SCIENCE

MAY 28, 1954

VOLUME 119 NUMBER 3100

Contents

AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

The U.S. Geological Survey 75 Years of Service to the Nation, 1879–1954

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IN 75 years of professional scientific investigative work, the United States Geological Survey, Department of the Interior, has grown from an organization of 39 people to one of more than 6000. This growth has paralleled the development of the United States as a great industrial nation and has both resulted from and contributed to that development. The Survey's program, almost from the start, has been on a national scale, its activities being those that could be accomplished only by the Federal Government. Its growth, reflecting the confidence of Congress, state and other governmental units, industry, and the public in general, also indicates a continuing and vital need for its fact-finding work.

Many know something about the Survey, but the details of its history and functions are probably little known to those who are not in regular contact with it. In the words of Director W. E. Wrather, the Survey's work is seldom of a spectacular nature and does not usually produce startling headlines in the daily press.

It is our intent in this article to describe the origin, history, and work of the Survey. Such an account must necessarily be brief and sketchy; a full history of the Survey would fill many volumes. The origin and first years of the Survey are treated in some detail, as is its internal organization during those years. For later years, less detail is used and the internal organization is not described, in order to place greater emphasis on the broad results of its work. In the same way, the members of the Survey for the early years are treated at greater length than those of later years.

Published sources for this account are the annual reports of the director of the Survey, Congressional documents, biographic memoirs of the National Academy of Sciences, publications of the Geological Society of America, other scientific journals, the Institute for Government Research Service Monograph No. 1 of the United States Government, George P. Merrill's *Contributions to the History of American Geology*, and many other reports referred to in the text. In addition, unpublished administrative reports and manuscripts in the files of the Survey have been consulted. Finally, many members of the Survey have supplied material from their memories and opinions, and we are grateful for their help.

Origin of the Geological Survey

During the first four decades of the 19th century, the surveys conducted by the Federal Government were chiefly exploratory in character and were confined almost wholly to the western part of the country. Many surveys were made at an early date, most of them by the Army, partly for military use and partly to extend geographic knowledge. Among these early expeditions were the Lewis and Clark explorations of 1803–07, the Pike expedition to the Rocky Mountain area in 1805–07, the Long expedition to the Rocky Mountains in 1819–20, in which Edwin James served as geologist, the field trips of Featherstonhaugh (first man to bear the title of "U.S. geologist") to the Ozark Mountains in 1834, and the examination of the mineral lands of the upper Mississippi Valley for land-classification purposes by Owen in 1839–40 for President Van Buren.

Of these and later surveys, it was said by Clarence King (*1*), first director of the Geological Survey, that

> Up to 1867, geology was made to act as a sort of camp-follower to expeditions whose main object was topographical reconnaissance. Charged with definite objects and missions, the leaders of these corps have tolerated geology rather as a hindrance than a benefit. In consequence, such subsidiary geological work amounts to little more than a slight sketch of the character and distribution of formations, valuable chiefly as indicating the field for future inquiry.

In 1867, however, the picture changed. Between 1867 and 1869, Congress authorized three surveying expeditions in which geologic studies were the main or sole objects and a fourth in which they occupied a prominent place. The work of these surveys has been briefly and well described (*2*) as follows:

> 1) *Geological Exploration of the Fortieth Parallel.* The act of March 2, 1867 (14 Stat.L., 457) provided for "a geological and topographical exploration of the territory between the Rocky Mountains and the Sierra Nevada Mountains, including the route or routes of the Pacific Railroad." This survey was made under the jurisdiction of the War Department but its director, Clarence King, was a civilian, as were also his scientific assistants. The territory surveyed comprised a belt 105 miles in width extending from longitude 104°30′ to longitude 120°—that is, from Cheyenne, Wyoming, to the eastern border of California. The survey was primarily geological in character but included also the topography of the region. The results of the survey were published in 1870–1880 in seven volumes and an atlas. The total cost of the survey and its publications was $383,711.
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> 2) *Geological and Geographical Survey of the Territories.* The act of March 2, 1867 (14 Stat.L., 471, sec. 2) called for "a geological survey of Nebraska,

said survey to be prosecuted under the direction of the Commissioner of the General Land Office." F. V. Hayden was assigned to this work and was subsequently designated United States geologist for the territories of Colorado and New Mexico. As the work progressed, its scope was by the authority of Congress extended over all the territories and work was done in Wyoming, Idaho, Montana, New Mexico and Colorado, the total area embraced in systematic surveys reaching about 100,000 square miles. This survey was primarily geological, but its activities included work on topography, geology, paleontology, ethnology, philology, botany and kindred sciences. The results were published in a series of volumes which were issued from 1867 to 1883.

The original appropriation for this survey was only $5,000 but this was increased by successive annual appropriations of $10,000, $25,000, $50,000, $75,000, $115,000, $110,000, $95,000, $65,000, $75,000 and $75,000, as well as by a specific appropriation of $30,000 to complete maps and office work; so that the total cost of the survey amounted to $735,000 exclusive of the cost of printing and engraving and of the services of several officers detailed from the Army.

3) *Geographical and Geological Survey of the Rocky Mountain Region.* In 1867 the Smithsonian Institution began an exploration of the Colorado River. This survey was later recognized by Congress in a joint resolution, approved July 11, 1868 (15 Stat.L., 253), authorizing the Secretary of War "to issue rations for twenty-five men of the expedition engaged in the exploration of the river Colorado under direction of Professor Powell, while engaged in that work." Additional appropriations, $54,000 in all, were granted in 1870–73, the expedition still remaining under the control of the Smithsonian Institution. On the completion of the survey of the Colorado River, Powell was, by act of June 23, 1874 (18 Stat.L., 207) authorized to continue the survey in Utah under the direction of the Secretary of the Interior; and subsequent acts of appropriation authorized the extension of the field of survey to the "Rocky Mountain region." In all, the area surveyed was 67,000 square miles embracing southern Wyoming, central and southern Utah and adjacent portions of Nevada and Arizona. This survey was primarily exploratory and geographical but, in addition to the triangulation of the whole region and the establishment of the geodetic points, it included work in topography, ethnology, geology, botany, paleontology and kindred sciences.

The results of the survey were not published in full, the only printed documents produced being two brief reports in 1877 and 1878 by Powell.

Though the appropriations for the survey amounted only to $244,000, the total cost, not including engraving and printing, as stated by Powell in a letter to the Secretary of the Interior, was $279,000.

4) *Geographical Survey West of the One Hundreth Meridian.* An act approved June 10, 1872 (17 Stat.L., 367) authorized a "continuance of military and geographical surveys and explorations west of the one hundreth meridian of longitude." The survey was made under the jurisdiction of the War Department, Lieutenant George M. Wheeler, of the Engineer Corps, being placed in charge. This survey, as its name implies, covered all the territory west of the one hundreth meridian, which includes the western parts of the Dakotas, Nebraska, Kansas and Texas, the Rocky Mountain states, and the Pacific Coast states. This survey was primarily geographical or topographical, but, as was stated in the report of the Chief of Engineers to the Secretary of War on May 10, 1878 (House Executive Document No. 88, 45th Congress, 2d Session), was so made as to obtain "at the same time and as far as practicable without greatly increasing the cost, all the information necessary before the settlement of the country, concerning the branches of mineralogy and mining, geology, paleontology, zoology, botany, archaeology, ethnology, philology, and ruins."

The survey was brought to a close in 1879 and its results were published in 1875–1889 under varying titles.

The original appropriation for this survey was $75,000, but a series of additional appropriations for continuing the survey, for engraving and printing, and for completing the office work of the survey brought the total direct appropriations for the survey up to the sum of $618,644. If to this sum is added the value of the aid and supplies received from the War Department and the salaries of regular Army officers detailed to the survey, the cost of the survey appears to have been $805,340.

In writing of these surveys, King says (*1*):

> Eighteen sixty-seven, therefore, marks in the history of national geological work, a turning point, when the science ceased to be dragged in the dust of rapid exploration and took a commanding position in the professional work of the country.
>
> Congress, even then, hardly more than placed the Federal work on a par with that prosecuted by several of the wealthier States. During the years when the Federal geologists were following the hurried and often painful marches of the western explorers, many States inaugurated and brought to successful issue State surveys whose results are of dignity and value.
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> Since 1867 the Government work has been equal to the best State work, and in some important branches has taken the lead. The wisdom of the legislation which placed in the field those well organized, well equipped, and ably-manned corps is apparent in the improved and enlarged results obtained.
>
> But there remained one more step necessary to give the highest efficiency and most harmonious balance to the National geological work. It was the discontinuance of the several Geological Surveys under personal leadership, and the foundation of a permanent Bureau charged with the investigation and elucidation of the geological structure and mineral resources and productions of the United States.

That there was need for such a step was beginning to be apparent in 1874. In the early 1870's, bitter rivalry had sprung up between Hayden and Wheeler. The rivalry was mainly a personal contest for prestige and appropriations, but it precipitated a hearing in the spring of 1874 before the House Committee on Public Lands. On April 15, the House adopted a resolution (*3*):

> *Resolved*, That the President of the United States

be requested to inform the House what geographical and geological surveys under different departments and branches of the Government are operating in the same and contiguous areas of territory west of the Mississippi River, and whether it be most practicable to consolidate them under one department, or to define the geographical limits to be embraced by each.

In answer to the resolution, President Grant sent a message (*3*) to the House on April 30. In this message, he transmitted the views of the War and Interior Departments and went on to say that

> Where surveys are made with the view of sectionizing the public lands, preparatory to opening them for settlement or entry, there is no question but such surveys, and all work connected therewith, should be under the direct control of the Interior Department, or the Commissioner of the General Land Office, subject to the supervision of the Secretary of the Interior. But where the object is to complete the map of the country; to determine the geographical, astronomical, geodetic, topographic, hydrographic, meteorological, geological, and mineralogical features of the country; in other words to collect full information of the unexplored, or but partially known, portions of the country, it seems to me a matter of no importance as to which Department of the Government should have control of the work. The conditions which should control this subject are, in my judgment, first, which Department is prepared to do the work best; second, which can do it the most expeditiously and economically.

He adds that he thinks the Army should do the job. The views of Hayden and Powell also accompanied the message; both men agreed that all scientific surveys should be in the Department of the Interior. The War Department recommended that all these surveys should be carried out by the Army.

Despite the hearings, no important changes were made in the surveys for 4 years. The situation changed, however, with the inauguration of Hayes to the Presidency in March 1877. Carl Schurz entered the Cabinet as Secretary of the Interior and immediately became active in efforts to reform the public-land system, a subject in which Powell took a deep interest. Reform of the public-land system and consolidation of the surveys became linked in a program fostered by Powell, which soon resulted in a struggle involving both political and scientific circles.

On March 8, 1878, John D. C. Atkins of Tennessee, Democratic chairman of the House Committee on Appropriations, had obtained passage of a resolution directing Schurz to supply information concerning possible consolidation of the surveys, and Schurz had replied with letters from Hayden and Powell which reiterated earlier discussion on a possible division of labor.

On the scientific front, new events were shaping partisanship. Joseph Henry, president of the National Academy of Sciences, died, and Othniel C. Marsh of Yale University became president. Marsh was a rival of Edward D. Cope for leadership in the field of vertebrate paleontology in America. There had been disagreements between Marsh and Hayden; Cope was an associate of Hayden as paleontologist of the Geological and Geographical Survey of the Territories. Marsh and King were in professional association, and King was in the Powell camp.

A group of Representatives associated with Abram Hewitt formed a plan to have the Academy back a reform of the land system and the geologic surveys. On June 20, 1878, Hewitt obtained passage of a clause in the appropriation act for sundry civil expenses of the Government, as follows (*4*):

> And the National Academy of Sciences is hereby required at their next meeting, to take into consideration the methods and expenses of conducting all surveys of a scientific character under the War or Interior Department, and the surveys of the Land Office, and to report to Congress, as soon thereafter as may be practicable, a plan for surveying and mapping the Territories of the United States on such general system as will, in their judgment, secure the best results at the least possible cost; and also to recommend to Congress a suitable plan for the publication and distribution of reports, maps, and documents, and other results of the said surveys.

Marsh appointed a committee consisting of James D. Dana, William B. Rogers, J. S. Newberry, W. P. Trowbridge, Simon Newcomb, and Alexander Agassiz. The committee report, which fully supported Powell's program, was submitted by Marsh to the House on November 26, 1878, after the Academy had adopted it on November 6. The report recommended (*4*):

> 1) In view of the paramount importance of the public lands, . . . that the coast and geodetic survey be transferred from the Treasury Department to the Department of the Interior, retaining its original field of operations, and assuming also the entire mensuration of the public domain, and that, so modified and extended, it hereafter be known as the United States Coast and Interior Survey. This organization would then embrace, in addition to its former work, a geodetic survey of the whole public domain, a topographical survey comprising detailed topographical work and rapid reconnaissance, and land-parceling surveys. The Superintendent of the Coast and Interior Survey should be appointed by the President, and should report directly to the Secretary of the Interior.
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> 2) The best interests of the public domain require, for the purposes of intelligent administration, a thorough knowledge of its geological structure, natural resources and products. The domain embraces a vast mineral wealth in its soils, metals, salines, stones, clays, &. To meet the requirements of existing laws in the disposition of the agricultural, mineral, pastoral, timber, desert, and swamp lands, a thorough investigation and classification of the acreage of the public domain is imperative. The committee, therefore, recommend that Congress establish, under the Department of the Interior, an independent organization to be known as the United States Geological Survey, to be charged with the study of the geological structure and economical resources of the public domain, such survey to be placed under a director,

who shall be appointed by the President, and who shall report directly to the Secretary of the Interior. It should be specially provided that the director and members of the geological survey, charged as they are with the investigation of the natural resources of the public domain, shall have no personal or private interests in the lands or mineral wealth of the region under survey, and shall execute no surveys or examinations for private parties or corporations.

3) The publications of the Geological Survey should consist of an annual report of operations, geological and economic maps, illustrating the resources and classification of the land, reports upon general and economical geology in all its branches, with the necessarily connected paleontology.

All collections made by the Coast and Interior and Geological Surveys, when no longer needed for the investigations in progress, should be transferred to the National Museum.

The following recommendations were also offered:

4) Discontinuance of the Wheeler, Hayden, and Powell surveys.

5) Abolition of the offices of surveyors general and of the system of land-parceling surveys by private contractors.

6) Appointment of a public-lands commission to codify the land laws.

Debate on the report reached the floor of the House in February 1879. Hayden, in alliance with a large western bloc in Congress, opposed the Academy program. King gave effective support to Hewitt, and Powell campaigned to build up sentiment in favor of it. The program was not introduced to the House by the Committee on Public Lands. Instead, the new legislation was attached to the Legislative, Executive, and Judicial Appropriation Bill and to the Sundry Civil Expenses Bill, which would be reported by the Committee on Appropriations of which Atkins was chairman and Hewitt a member. Some have thought that the legislation was drafted by Powell or by a member of his staff under his direction.

Debate in the House was bitter and was mainly on a sectional basis, the western members being overwhelmingly against the proposal and many eastern members favoring it. Opposition in the Academy was claimed by Representative Dudley C. Haskell of Kansas by way of a letter from an anonymous member of the Academy which named Spencer Baird, Joseph Leidy, and Arnold Guyot.

After long debate, a compromise was proposed by Representative Horace F. Page of California on February 18 which called for consolidation of the scientific surveys and the appointment of a public-lands commission but which knocked out the provision for a change in the land system and the land-parceling surveys. This passed the House 98 to 79 but was dropped without debate in the Senate. The appropriation bill then went to a conference committee.

In conference, the provision for the consolidation of the scientific surveys into one organization, the United States Geological Survey, and for the appointment of a public-lands commission was inserted into the Sundry Civil Expenses Bill. In the closing rush of this third session of the 45th Congress, the conference report was accepted, 35 to 24 in the Senate and 148 to 107 in the House. The assumption is that, with the controversial reform of the land system reduced to a provision for an investigation, serious opposition to the consolidation of the surveys melted away. President Hayes signed the bill on March 3, and the Geological Survey came into being.

With the establishment of the Survey, the controversy shifted to the appointment of a director. Powell opposed the nomination of Hayden and asked Atkins to use his influence with Schurz and President Hayes to prevent it. Atkins did so and recommended Clarence King. Powell vigorously supported this recommendation and kept in touch with Marsh, who came to Washington to add his support.

Cope, on the other hand, supported Hayden and urged Schurz to recommend his appointment. King, however, was nominated March 20, and after a favorable report by the Senate Committee on Public Lands, the nomination was confirmed April 3. On April 6 Marsh wrote to Powell (*5*):

> Now that the battle is won we can go back to pure Science again. I therefore invite you and Mr. Gilbert to attend the coming meeting of the National Academy beginning April 15th and hope you both will have some papers to present.

With King director of the Survey, there was some question of Powell's relationship to the new organization. King invited him to become a member; Powell accepted, and King replied (*5*):

> Your welcome telegram came to me Saturday. I am more delighted than I can express. Hamlet with Hamlet left [out] is not to my taste.

Organizing the Survey, 1879–81

Clarence King took the oath of office May 24, 1879, as first director of the Survey. S. F. Emmons said (*6*) that King "accepted the appointment with the distinct understanding that he should remain its head only long enough to appoint its staff, organize its work, and guide its full activity." He was well fitted for these functions.

Born in Newport, Rhode Island, in 1842, King graduated in 1862 from the Sheffield Scientific School at Yale, where he studied geology and mineralogy under James D. Dana and George J. Brush. From 1863 to 1865, he was a volunteer assistant to J. D. Whitney of the Geological Survey of California. During the winter of 1865–66, he made an exploration of the desert regions of southern California and Arizona as scientific aide to General McDowell. The experience gained during this period developed latent powers of enterprise, energy, and scientific ability and leadership which characterized his career. In 1866–67, he organized the Geological Survey of the Fortieth Parallel, which he directed during the 7 years of its existence. The work of this survey under his direction was very important; Emmons said (*6*) that it was

. . . the first government exploration primarily devoted to geological investigation, the first geological Survey in the country to make and publish topographical maps as a basis for its geology, the first to employ microscopical petrography in the study of its rocks, and the first to institute systematic geological examinations of mining districts with a view of establishing a more satisfactory theory of vein formation.

Thus King brought to the task of organizing the new Survey an array of scientific achievement and organizing ability that would assure its firm foundation.

The Act of March 3, 1879 (the organic act), creating the new agency, is remarkable for its brevity. It is as follows (*7*):

> For the salary of the Director of the Geological Survey, which office is hereby established under the Interior Department, who shall be appointed by the President, by and with the advice and consent of the Senate, six thousand dollars; *Provided*, That this officer shall have the direction of the Geological Survey, and the classification of the public lands, and examination of the Geological Structure, mineral resources, and products of the national domain. And that the Director and members of the Geological Survey shall have no personal or private interests in the land or mineral wealth of the region under survey, and shall execute no surveys or examinations for private parties or corporations; and the Geological and Geographical Survey of the Territories, and the Geographical and Geological Survey of the Rocky Mountain Region, under the Department of the Interior, and the Geographical Surveys west of the One-hundreth Meridian, under the War Department, are hereby discontinued, to take effect on the thirtieth day of June, eighteen hundred and seventy-nine. And all collections of rocks, minerals, soils, fossils, and objects of natural history, archaeology, and ethnology, made by the Coast and Interior Survey, the Geological Survey, or by any other parties for the Government of the United States, when no longer needed for investigations in progress, shall be deposited in the National Museum.
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> For the expenses of the Geological Survey, and the classification of the public lands, and examination of the geological structure, mineral resources and products of the national domain, to be expended under the direction of the Secretary of the Interior, one hundred thousand dollars. . . .
>
> The publications of the Geological Survey shall consist of the annual reports of operations, geological and economic maps illustrating the resources and classification of the lands, and reports upon general and economic geology and paleontology. The annual report of operations of the Geological Survey shall accompany the annual report of the Secretary of the Interior. All special memoirs and reports of said Survey shall be issued in uniform quarto series if deemed necessary by the Director, but otherwise in ordinary octavos.

King regarded this language as leaving some room for doubt as to the functions of the Survey and its field. He decided that Congress intended a rigid classification of the lands of the public domain (*1*),

> . . . for the general information of the people of the country, and to produce a series of land maps which should show all those features upon which intelligent agriculturists, miners, engineers, and timbermen might hereafter base their operations.

On the question of whether the term *national domain* meant the entire United States or merely the public lands, he decided that (*1*)

> With the small appropriation given to begin the vast work of this Bureau, I considered it best to confine the operations to the region of the Public Land, concerning which field there could be no question as to my legal authority.

On the question of organizing the new work, he noted that former surveys had operated by annual campaigns in the West and that the members returned to Washington in the winter and that this was wasteful of time and money. He therefore decided to divide the region of the 101st meridian into four geologic districts, which he called divisions.

These divisions were (i) the Rocky Mountain division, embracing generally the chain of the Rocky Mountains, S. F. Emmons, geologist-in-charge, with headquarters in Denver, Colorado; (ii) the division of the Great Basin, embracing the country between the Rockies and the Colorado Plateau on the east, and the Sierra Nevada and the Pacific Coast and Cascade Ranges to the west, G. K. Gilbert, geologist-in-charge, with headquarters at Salt Lake City, Utah; (iii) the division of the Pacific, covering all of Washington Territory, that part of Oregon west of the Blue Mountains, and all of California except the desert regions east of the Sierra Nevada and south of latitude 38°, Arnold Hague, geologist-in-charge, with headquarters in San Francisco; and (iv) the division of the Colorado, embracing the plateau and canyon country between the Rocky Mountains and the Great Basin, Captain C. E. Dutton, U.S. Ordnance Corps (detailed to the Survey), geologist-in-charge, with headquarters in Salt Lake City. One office and one laboratory were to serve both this and the Great Basin division.

In addition to these, King intended to set up four divisions east of the 102nd meridian if a pending House resolution extending the field of the Survey to the whole country were enacted. The resolution died in the Senate, and it was not until 1882 that the coverage was specifically extended by Congress in the words (*8*) "and to continue the preparation of a geologic map of the United States." Provision for further geographic expansion of the work of the Survey was made in 1888.

King reasoned that, by placing each division in charge of a competent geologist familiar with the problems of that division and assigning to him a corps of competent assistants, the work would be done better than by expeditionary corps moving from division to division.

Probably King's most important contribution to the successful organization of the Survey was the magnificent staff that he gathered to it. The staff was led by seven men who, individually and collectively, were

of the very highest geologic distinction. They were S. F. Emmons, Arnold Hague, G. K. Gilbert, F. V. Hayden, Raphael Pumpelly, George F. Becker, and Captain C. E. Dutton, detailed from the Ordnance Corps. Together with A. D. Wilson, chief topographer, Gilbert Thompson, topographer, W. F. Hillebrand, chemist, Joseph P. Iddings, assistant geologist, Charles D. Walcott, assistant geologist, with other young scientists, clerks, messengers, and watchmen, they formed a compact group of 39 people, the charter members of the Survey.

Of these, G. K. Gilbert attracts the most attention. Born in Rochester, New York, in 1843, he graduated from the University of Rochester in 1862. At that time he was mainly interested in mathematics and engineering, not particularly so in geology, and was well versed in Greek and Latin. After a short venture in teaching, he returned to Rochester where he entered Cosmos Hall, founded by Henry A. Ward, professor of geology and natural history. Cosmos Hall was described as a training school in the natural sciences, and Gilbert's association with it aroused his latent scientific interests and talents.

His next venture was as volunteer assistant under John S. Newberry on the Second Geological Survey of Ohio, which he joined in 1869. Here he gained geologic experiences and acquaintances, which prepared him for his first assignment, the Wheeler Survey, in 1871. His connection with the Wheeler Survey lasted until 1874. In the summer of 1872, he had his first introduction to Lake Bonneville and to northern Arizona. While in Washington in January 1872, he had met Powell, and they found that they had much in common. They were both geologic explorers; both had worked in the same or contiguous areas; both had the imagination to be stirred by the magnificence of the area; and both were intellectually enthusiastic about the many problems presented by the arid lands. They also complemented each other. Powell was aggressive, fertile in ideas, a great organizer and generalizer. Gilbert was steady in thought and accurate in observation, somewhat diffident and retiring in personality. Each tremendously admired the other, and they formed a close and lasting association.

It naturally followed that Gilbert joined the Powell survey in 1875, where he worked on the Aquarius Plateau, the Water Pocket fold, and the Henry Mountains. The following summer he worked entirely in the Henry Mountains and in 1877 worked with Powell on irrigation studies. In 1878 he spent the summer designing and executing a triangulation system in the Colorado Plateau Province as a base for topographic surveys.

Out of this work came Gilbert's Henry Mountains report (*9*), which defined the concept of laccolithic structure and which contains the celebrated chapter on "Land sculpture." Much of the material in this chapter had been published in a paper, "The Colorado Plateau Province as a field for geological study" (*10*), a model of clear, simple, logical scientific writing.

All this was a prologue to Gilbert's logical move to the new Survey. Thus began a career with that body of 40 years which raised Gilbert to a position as one of the most eminent scientists of his generation.

S. F. Emmons, a scientist of probably equal distinction, was born in Boston, Massachusetts, in 1841. He graduated from Harvard in 1861 and studied in Paris and at the Freiberg Mining School in 1862–65. At Freiberg, he had an unparalleled opportunity to associate with world-famous scientists in geology, mineralogy, and mining, and it was here that he laid the groundwork of his later fundamental contributions to mining geology.

In 1867 he joined King's Fortieth Parallel Survey along with J. D. Hague and Arnold Hague, all as assistant geologists. The winter of 1867–68 was spent at Virginia City, Nevada, in the study of the Comstock Lode, which by that time was being mined at depths of 1000 ft. Emmons remained with this survey throughout its life and participated in its publications which appeared in 1870–80.

Emmons brought to the new Survey an interest in and acquaintance with ore deposits which would prove immensely valuable in its work in mining geology.

F. V. Hayden's distinction in geology had been gained through the work of his survey which had a great following among many scientists and the public. He was born in Westfield, Massachusetts, in 1829 and graduated from Oberlin College in 1850. He was assistant to James Hall in 1853 and engaged in independent geologic work in the West in 1854–56. He was connected with a number of different expeditions and surveying parties until 1865, when he became professor of geology and mineralogy at the University of Pennsylvania. From 1869 to 1879 he was director of his celebrated survey.

Hayden brought to the new Survey a vast body of experience which added to the collective distinction of the staff.

Arnold Hague, born in Boston, Massachusetts, in 1840, entered the Sheffield Scientific School in 1861, where he became associated with King, Marsh, J. Willard Gibbs, and Ellsworth Daggett. On graduating in 1863, he went to Germany, spending a year in Göttingen and the next year in Bunsen's laboratory, where he devoted his time to chemistry and mineralogy. From Heidelberg he went to Freiberg, where he met S. F. Emmons, who had been there for a year. They began an intimate association which lasted a lifetime. It was then that Hague, as well as Emmons, became influenced by Bernhard von Cotta, author of a textbook on petrography, *Die Gesteinlehre*, which conditioned their interest in the petrography of igneous rocks.

On his return to the United States in 1866, Hague met King in New York and was offered a position as assistant geologist on King's proposed Fortieth Parallel Survey. He gladly accepted and a few weeks later introduced Emmons to King, which led to the appointment of Emmons.

The results of Hague's geologic work in connection with this survey contributed to the beginnings of

microscopical petrography in the United States, and Hague shares with Emmons the credit for visualizing the importance of this branch of science to American geology.

In 1877, Hague became government geologist of Guatemala, where he studied the mines and volcanic districts. In 1878 he went to China to study the gold, silver, and lead mines for the Chinese Government. From this assignment, he went to the new Survey.

Another who came to the Survey from the Fortieth Parallel group was George F. Becker. He was born in the City of New York in 1847, spent his early life in Cambridge, Massachusetts, and graduated from Harvard in 1868. He took advanced degrees at Heidelberg in 1869 and at the Royal School of Mines in Berlin in 1871. His major subjects of study were mining and metallurgy, and he became instructor in these subjects at the University of California. Having met King during this period, and being attracted strongly by Emmons and Hague, he became interested in the geologic problems developed during the King survey, especially those of the Comstock Lode. Geophysics became his chief interest.

Raphael Pumpelly, born in Oswego, New York, in 1837, had been employed in economic work by the Japanese and Chinese governments in 1862–63. In 1865 he was appointed professor of mining engineering at Harvard. He was state geologist of Michigan in 1869–71 and director of the state survey of Missouri in 1872–73. On joining the Geological Survey under King, he began the work in mineral statistics which was continued for many years.

Captain C. E. Dutton, born in Wallingford, Connecticut in 1841, graduated from Yale in 1860. He entered the United States Army in 1862 and, after the close of the Civil War, studied geology in his leisure. He joined the Powell survey on detail from the Army, which gave him an opportunity to gain professional standing. This detail was renewed in 1879 when he joined the Geological Survey and continued until 1891. Dutton's familiarity with the canyon country made him the logical man to be put in charge of the division of the Colorado to finish some of Powell's work.

Among this brilliant group of men, it is obvious that there was one missing. Where was the Hamlet of whom King had written in his letter to Powell? The appropriation act setting up the Geological Survey also created the Bureau of Ethnology in the Smithsonian Institution, and Powell, whose interest in ethnology equaled, if it did not exceed, his other scientific interests, became its director. He first joined the Survey when he became its director in 1881, retaining the direction of the Bureau of Ethnology without additional compensation. He continued this dual role until his resignation from the Survey in 1894 but continued as head of the Bureau until his death in 1902.

The Survey set to work. Washington headquarters were established in the National Museum. Emmons, in Denver, fitted up the first chemical laboratory, noting that chemical investigations would be a necessary part of his study of mining districts and the formation of ore deposits. To this laboratory, he brought W. F. Hillebrand and A. Guyard, who, he says, had made a specialty of this work, having studied under the best teachers in America and abroad. Hillebrand, of course, went on to become the foremost chemist of his time in inorganic chemical analysis, and it was through his work and his later associates that the Geological Survey became preeminent in the field of inorganic chemical analysis of rocks, minerals, ores, and other natural products, a place that it holds today.

C. W. Cross, who had just graduated from the University of Leipzig, where he had studied microscopical petrography, began, under Emmons' direction, a systematic examination of thin sections of 345 specimens of crystalline and eruptive rocks collected during Emmons' first summer's work.

Fred A. Clark, topographer, began making triangulation, leveling, and topographic surveys in the Eureka district, Nevada, under the general supervision of Arnold Hague.

G. F. Becker began his detailed study of the Comstock Lode. As a part of this work, he became interested in the relationship of electric currents in ore bodies and said that should this be worked out it would probably be adaptable to the discovery of new ore bodies. He also investigated temperatures and heat gradients in the Lode, noting, for instance, that on the 2700-ft level of the Yellow Jacket mine he found water at 153°F, with the air and rock temperatures at 125°F. He related this heat to remnants of volcanic action.

These studies, actively encouraged by King, can be said to be the first geophysical work in the Geological Survey.

In cooperation with the Census Bureau, the collection of statistics on yearly mineral production in the region west of the 100th meridian was begun under the direction of Raphael Pumpelly.

A survey of work in progress at the time King wrote the first annual report (*1*), November 1, 1880, is best illustrated by his list of "forthcoming publications":

Geology and mining industry of Leadville, Colorado, by S. F. Emmons.
Geology of Eureka mining district, Nevada, by Arnold Hague.
History of the Comstock mines, by Eliot Lord.
The Comstock Lode, by George F. Becker.
Mechanical appliances used in mining and milling on the Comstock Lode, by W. R. Eckart.
Coal of the United States, by Raphael Pumpelly.
Iron in the United States, by Raphael Pumpelly.
The precious metals, by Clarence King.
Lesser metals and general mineral resources, by Raphael Pumpelly.
Uinkaret Plateau, by C. E. Dutton.
Lake Bonneville, by G. K. Gilbert.
Dinocerata. A monograph on an extinct order of ungulates, by O. C. Marsh.

Thus the Survey was making investigations both practical and theoretical, or as we would label them today, applied science and basic research. King (*1*) could see the need for facts on a national scale to assure the development of our "material resources." To marshal these facts he saw

> . . . the necessity of a Government corps of geologists, topographers, mining engineers, metallurgists and chemists; . . . and this corps must be so directed . . . that the facts learned in one place may be made to throw light on all others.

The Survey was a going concern.

The Expanding Survey, 1881–94

Early in February 1881, King learned that Carl Schurz planned to resign as Secretary of the Department of the Interior as soon as Garfield assumed the Presidency in March, and he immediately tried to resign also. President Hayes persuaded him to wait. He did but submitted his resignation to President Garfield on March 11, having recommended John Wesley Powell as his successor. The resignation was accepted March 12. Powell was nominated March 14, was confirmed March 18, and was sworn into office March 19.

An admirer, Lester F. Ward, wrote on that occasion (*11*):

> John Wesley Powell is a pattern of the American self-made man, and well illustrates what may be accomplished with honest, steady adherence to a definite purpose.

Born in Mount Morris, New York, in 1834, Powell was largely self-taught. He attended Illinois College, Illinois Institute, and Oberlin in periods interspersed with intervals of teaching school in the years preceding the Civil War. He enlisted in the Union Army in 1861 and served throughout the war, reaching the rank of major, and lost his right arm from a wound received in the Battle of Shiloh. After the war, he became professor of geology at Illinois Wesleyan University and Illinois Normal University. His was the first party to explore the canyons of the Colorado River, in 1869. From 1871 to 1879, he was director of the Powell survey.

Powell was undoubtedly one of the great men of American history. He was one of the first to visualize the potentialities of the western lands in all their ramifications, and he has become a legendary figure in the history of the West. A recent biography by William Culp Darrah (*12*) provides a fuller account of his life.

Powell brought to the Survey experience and a keen interest in geology, topographic mapping, and irrigation. He was an able leader of men, resourceful, courageous, and persevering. He had that indispensable quality of a good administrator—the ability to surround himself with competent men and the wisdom to give them responsibility while holding in his own hands the policy-making functions. He had a goal for the Geological Survey from which he never deviated: to establish it as a great scientific and technical bureau with emphasis on research in all its functions. In this he succeeded, probably beyond his own expectations.

Powell had a concept different from that of King in the management of the Survey. He abolished the divisions as the somewhat autonomous bodies that they were and transformed the Survey's program into a truly national one with Washington as the nerve center. That this step may have involved other considerations is implied in a reputed statement in his diary that he did not so much mind each division lobbying in Congress for greater appropriations but when they lobbied against one another it was time for a change.

The change was illustrated in a communication by Powell to the October 1884 meeting of the National Academy of Sciences on the organization and plan of the Geological Survey (*13*). At this time the roster had grown to 135, and the appropriation (fiscal year 1885) to $504,000.

Five paleontological laboratories had been established under the supervision of O. C. Marsh. W. H. Dall, C. A. White, C. D. Walcott, and Lester F. Ward, respectively.

A physical laboratory had been established for researches related to the effect of temperature, pressures, and related phenomena on rocks. In 1882, these researches were under the direction of King as an outgrowth of the work of Becker on the Comstock Lode. This early work led to plans for the acquisition of suitable equipment for a physical laboratory. This equipment was constructed in Europe, and the expenses were met by King out of his own pocket. It was planned to set up the equipment in the American Museum of Natural History, but by the time it arrived the Museum had other plans for the space, and a house was rented for a laboratory in New Haven. However, in July 1883, Powell decided to consolidate all Survey laboratories in Washington under the direction of a chief chemist. The laboratory was therefore established in the Smithsonian Institution and, together with the chemical laboratory, was placed under the direction of F. W. Clarke, newly appointed chief chemist. The laboratory continued without serious interruption until 1892, when the annual appropriation for physical and chemical research was reduced from $17,000 to $5000 and all physical research was abandoned. During this period, G. F. Becker and Carl Barus made important contributions in the thermoelectric measurement of high temperatures.

A "chemic" (*14, 15*) laboratory had a large corps of chemists engaged in researches related to the constituents of waters, minerals, ores, and rocks. A part of the work was the study of metamorphism and paragenesis of minerals, and in these studies the chemists did fieldwork. At other times, they studied material collected by the field geologist.

A library had been established and it now had 25,000 volumes, of which the nucleus was 1000 volumes donated by Hayden. The librarian, C. C. Darwin, had a corps of assistants engaged in bibliographic work. Plans called for the preparation of a catalog of American and foreign publications on American

geology and for the publication of special bibliographies on various aspects of geology.

The publications of the Survey consisted of annual reports, bulletins, and monographs. By October 1884, nine bulletins had been published and seven were in press. Six monographs had been published and five were in press. Four annual reports had been published and the fifth was in press.

In economic geology, two so-called "mining divisions" had been organized, one in San Francisco under G. F. Becker, engaged in the study of quicksilver deposits in California, the other in Denver under S. F. Emmons, engaged in the study of the mining districts of Colorado. The lignite coals of the upper Missouri were also being studied by a party led by Bailey Willis.

In the field of general geology, the changes from the King system were most noticeable. The compilation of a general geologic map was in progress, together with a thesaurus of American formations. It then became necessary to consider the best division of the work, and it was decided to divide it, so far as possible, by subject matter rather than by territorial areas. There was therefore established a division of glacial geology under T. C. Chamberlin, with a plan for broadening the division to include the whole of Quaternary geology; a division of volcanic geology under Dutton; two divisions on Archean rocks, including all "metamorphic crystalline schists," one under Pumpelly concentrated in the Appalachian region, and one under Roland D. Irving in the Lake Superior region, with plans to cover the Rocky Mountains; a division for the study of areal, structural, and historical geology of the Appalachian region under Gilbert; and a division for a topographic and geologic survey of Yellowstone Park under Arnold Hague. Thus with the new congressional authority to prepare a geologic map of the United States, Powell was able to set up this broadly based work in general geology.

Finally, the Survey was making a topographic map of the United States. Powell said that sound geologic research is based on geography and, therefore, the topographic map comes first. First, the trigonometric survey was made, on a scale only sufficiently refined for map-making purposes, with the hypsometric work based on the network of railroad levels.

The topographic work was based largely on the use of the plane table, regarded not as a portable drafting table for field use but as a triangulation instrument.

Map scales were 1:250,000, 1:125,000, and 1:62,500, with larger scales being used in special districts. On this plan, Powell thought the country could be covered with 2600 sheets besides several hundred special large-scale maps. With his organization, he thought the topographic map of the United States could be completed in 24 years; one-fifth of the country had already been completed, inclusive of the work of the state governments.

The topographic work was divided into an astronomic and computing division, a triangulation corps, and a topographic corps organized in 27 parties scattered across the country. All the work was under the supervision of Henry Gannett, chief geographer.

In addition to these major work corps, there were a division of mining statistics and a division of illustrations for the preparation of illustrations for Survey reports, under W. H. Holmes. The mining statistics were published in an annual report entitled *Mineral Resources*. The illustrations were also preserved for use by the public.

This organization along functional lines has been modified repeatedly since Powell's time, but it is still basic to the Survey's work.

Powell also reported on the relationship of the Survey to state governments. In 1884, for instance, a cooperative agreement had been made with Massachusetts in the undertaking of a topographic survey by the state, the expense of fieldwork to be divided equally between the Survey and the state, the Survey to engrave the maps and give transfers of the plates to the state. This was the first of many such agreements made since that time.

By 1884, the rapidly expanding appropriations for the Survey, the Signal Service, and the Hydrographic Office had been under discussion in congressional circles, and the Sundry Civil Appropriation Act of 1884 (*16*) called for a joint congressional commission to investigate and attain greater efficiency and economy in the administration of these bureaus. Hearings were held in 1885 and 1886, with Powell appearing for the Survey. Questions raised related to the value of topographic maps prepared on a small scale, the rate of progress toward completion and publication of the Survey's geologic maps, and the propriety of the wide scope of the Survey's scientific investigations and publications.

Two of the six members of the commission submitted a minority report criticizing the Survey, but the majority report (*17*) found that the Survey was "well conducted, and with economy and care, and discloses excellent administrative and business ability on the part of its chief." The investigation resulted, however, in requiring the Survey to submit detailed and specific estimates of the cost of each future publication for which specific appropriations would be needed. This provision, for fiscal year 1887, was reenacted in 1895.

An additional restriction in the appropriation of 1887 was the requirement that estimates for Survey expenses be itemized. Of about $737,000 appropriated for Survey work, $40,000 was appropriated for paleontological researches and $17,000 for physical and chemical research. Thus, these research activities were specifically recognized and approved by Congress and they were itemized in Survey appropriations for many years.

In October 1888, Congress authorized the Survey to undertake a study of the arid regions of the United States where irrigation was necessary to agriculture; to investigate the storage of water in dams, the capacity of streams, and the cost and construction of

reservoirs; to designate all lands useful for sites for reservoirs, canals, or ditches for irrigation purposes and all the lands susceptible to such irrigation. It was provided that all such lands would be withdrawn from entry. This gave the Survey direct administrative powers in the public domain and was the start of the water resources investigations which are now such a large part of its work. It also marked the beginning of reclamation work by the Federal Government.

The investigation became known as the Powell Irrigation Survey and began in 1888 with the assembling of a party of 14 under a young Harvard graduate, F. H. Newell, at Embudo, New Mexico, to learn how to measure the flow of streams by experimenting on the Rio Grande. The whole survey, however, consisted of a large force, composed mainly of topographic engineers, and within little more than a year 127 reservoir sites were segregated, with an area of more than 2500 mi², and 30 million acres of irrigable land were located in five distinct basins.

This action of the Survey led to the appointment of a special committee of the Senate which, in a report in 1890 (*18*), severely criticized the Survey for the policy used in guiding the work. The whole of the authorization of 1888 was withdrawn except for reservoir sites, and the appropriations for the survey of the arid lands were discontinued. The work was of inestimable value, however, in the results achieved in stream measurements and topographic maps.

Following this setback for Powell and the Survey, the storm clouds gathered. Federal science, largely in the Survey, had gained a very commanding position but it had also gained many enemies both in governmental and scientific circles. Old rivalries, such as those between Cope and Marsh and Hayden and Powell, played their part. Powell's supporters in Congress were being replaced by neutral or hostile newcomers. The storm began to break on the Survey in 1892, when the previous year's appropriation of $843,000 was reduced to $705,000, and it came to a head in 1893 with a further reduction in appropriation to $488,000. The heaviest reductions, proportionately, fell on chemical and physical researches. For the former the reduction was from $40,000 in 1892 to $10,000 in 1893 and for the latter from $17,000 in 1892 to $5000 in 1893. As previously noted, the physical laboratory was discontinued and the chemistry force was drastically reduced. An old chestnut, repeated throughout the years by Survey men and attributed to George Steiger, later chief chemist, claimed that "Hillebrand was retained because he was the best chemist, Clarke because he was the chief chemist, and Steiger because he was the cheapest chemist."

Darrah (*12*) says that Powell was the real target of the blow at the Survey. In any case, perhaps seeing that his usefulness to the Survey was ended and wishing to spend more time with his Bureau of Ethnology, Powell submitted his resignation on May 4, 1894, to take effect June 30.

In the 15th Annual Report (*19*) Powell wrote of his men:

> In this severance of our relations, . . . I cannot refrain from an expression of profound gratitude for the loyal and loving aid which they have given me, ever working together with zeal and wisdom to add to the sum of human knowledge. The roster of these honored men is found in ten-score volumes of contributions to knowledge and fifty-score maps familiar to the scholars of the world, and their names need no repetition here. . . .

The work of the Survey during Powell's directorship produced a body of reports which has probably never been equaled for their profound contributions to geologic and topographic knowledge. Among these were S. F. Emmons' report on the geology and mining industry of Leadville, Colo. (*20*), by which he became the founder of mining geology in America; T. C. Chamberlin's report on the mechanics of glacial erosion (*21*); C. E. Dutton's report on isostasy (in which he introduced the term) (*22*); G. K. Gilbert's report on Lake Bonneville (*23*); G. F. Becker's report on the Comstock Lode (*24*); R. D. Irving's report on the copper deposits of Michigan (*25*); O. C. Marsh's report on the Dinocerata (*26*); Henry Gannett's manual on topographic methods (*27*), and many others. In addition, W J McGee produced the first Survey geologic map of the United States in 1884 (*28*) and followed it up with a second map in 1893 (*29*); and Powell and Gilbert devised a system of nomenclature, symbols, and colors for geologic cartography (*30*) that has remained the American standard with but few changes for nearly 70 years.

This is only a small sampling of these extraordinarily productive years. From the small but solid beginnings of King, the Survey had become an outstanding scientific body in the latter years of the Powell regime. This was a challenge to the next director to keep it so.

Widening Endeavor of the Survey, 1894–1907

W. C. Mendenhall says (*31*) that G. K. Gilbert probably could have been the next director had he so desired but that he decided he would be more useful in research than in administration. In any case, Charles D. Walcott was approved by Powell as his successor and he became director on July 1, 1894.

Born in New York Mills, New York, in 1850, Walcott was collecting natural objects when he was 7 years old and became interested in fossils and geology at the age of 13. He was trained in the public schools and at Utica Academy and at 23 had planned to study at Harvard under Agassiz but that teacher's death led him to abandon this idea.

Walcott was appointed an assistant to James Hall, state geologist of New York, in 1876 and joined the Geological Survey as an assistant geologist in July 1879. The next 10 years marked his great activity in paleontologic and stratigraphic researches in western and eastern United States and in the type district of Wales which brought him to his position of authority in Cambrian geology and paleontology, the study of which constituted his great contribution to science. He brought to the directorship talents as a leading

geologist and a skilled executive with a sound business sense and a marked ability to coordinate policies. He equated science to service and said that the advancement of science implied the physical, mental, and moral advancement of the human race.

During the Walcott regime, with the controversial figure of Powell off the stage, congressional appropriations for the Survey recovered, becoming $501,000 in 1894, going over the million mark for the first time in 1902 ($1,023,000), and reaching $1,757,000 in 1907. Chemical research was expanded; the physical laboratory was reestablished and, having produced notable work in the investigation of hydrothermal alteration and related studies, went off to the newly established Geophysical Laboratory of the Carnegie Institution in 1907.

Mining geology and mining technology became an important part of the Survey's work. Mining geology, which Emmons had shown to be of prime importance in the study of ore deposits and the exploration for new deposits, had been embraced wholeheartedly by the rapidly burgeoning mineral industry, and it came to magnificent achievement through the fundamental work of another extraordinary scientist of the Survey, Waldemar Lindgren, who had joined the Survey in 1884. His careful study of district after district in western mining regions led to a masterly synthesis of observation and speculation based on microscopical, chemical, and physical studies, and culminated in his concept of the hydrothermal depth zones and the role of metasomatism in ore formation. Lindgren's contributions to mining geology and geologic theory cannot be overestimated.

From the first years, the Survey had established a close relationship to the mineral industries of the country through its publication annually of the *Mineral Resources of the United States*. It had investigated technologic processes in mining. This activity was recognized and encouraged by a congressional resolution in 1898 calling for the creation of a separate division of mines and mining, but the resolution was not enacted. However, in 1904, $30,000 was appropriated for analyzing the coals and lignites of the United States, and this was increased to $227,000 in 1905 to cover all fuels and for studying structural materials. An appropriation was later made, under the directorship of George Otis Smith, in 1908 for the investigation of mine safety in the territories and for studying the causes of explosions in mines. These investigations led to the addition to the Survey roster of a large staff of mining technologists, and these were split off to form the Bureau of Mines in 1910.

Up to 1891, the Survey had gathered, in connection with its regular geologic and topographic surveys, data related to forests. In 1891, the President was empowered by Congress to create forest reserves on the public lands, and the Survey had aided in the determination of the boundaries of these reserves. However, there was little definite information on the resources of the lands included in the reserves, so Congress, in 1897, appropriated $150,000 for a survey of the public lands that had been or would be made forest reserves by Executive action and placed this survey under the supervision of the director of the Geological Survey.

The Survey began a thorough study of the forest reserves. The work continued for the next 8 years and covered 75 million acres. Forty atlas sheets of land classification maps were one of the results of this study. The data collected furnished the basis for the regulations governing the reserves, with administration vested in the General Land Office. The work was transferred to a new Bureau of Forestry in the Department of Agriculture in 1905. George Otis Smith says (*31*) that most of all this activity stemmed from Walcott's interest in forestry, that he drafted the relevant legislation, and that

> . . . it was only his influence with the leaders of Congress that made any stand successful against the anti-reserve agitation, so that the legislative beginning of a national forest policy may also be credited to him.

In the field of water resources investigations, the Survey received a specific appropriation in 1894 of $12,500 for gaging streams, and for determining the water supply of the United States, including studies of underground water and artesian wells in arid and semiarid regions. This appropriation, increased annually, had reached $100,000 in 1901, and authorization for the preparation of reports on water utilization was added. Thus, a large body of water data accumulated and, on the passage of the Reclamation Act in 1902, administration was entrusted by the Secretary of the Interior to the Survey. The resulting Reclamation Service remained in the Survey under the direction of F. H. Newell until it became an independent service in the Department in 1907, when the work had progressed from the planning to the construction stage. Newell continued as director in the independent service.

One of the functions cited in the organic act of the Survey was the "classification of the public lands." King had interpreted this to mean geologic and mineralogic examination of the public lands without reference to the public-land laws. Congress had silently acquiesced in this interpretation for some 20 years. Increasingly, the General Land Office and the Secretary of the Interior solicited Survey opinion, based on Survey data or calling for new investigations, regarding the applicability of specific provisions of the land laws to various tracts of public lands. Pursuant to these necessities, the Survey undertook in 1907, with the approval of the Secretary of the Interior, systematic evaluation of the public lands thought to contain coal, and later there was added the examination of oil, phosphate, potash, and mineral lands, and of lands suitable for water-power sites and for enlarged homesteads.

At the time that Powell resigned, topographic mapping had become by far the largest single activity of the Survey. The mapping had progressed, and continued to progress, beyond the needs of the Survey

itself for strictly geologic purposes. The maps were becoming basic and standard for all purposes. They were becoming useful to all governmental units, state, national, and local, for all varieties of public works and were being used for engineering works by private enterprise. Authority to sell the maps to the general public was granted by Congress in 1897 (*32*). In 1896 Congress had authorized the running of careful level lines and the establishment of bench marks; this contributed to increased detail and quality in the work. Another important event early in the Walcott regime was the placing of the topographic engineers in the classified service in order to get the best qualified men. In addition, an editor for topographic maps was appointed.

Data had been gathered informally by the Survey in Alaska as early as 1889, but its first formal work there was authorized by Congress in 1895 when an appropriation of $5000 was made for a study of the coal and gold resources; the amount was continued in 1896 and 1897. Because of the Klondike rush in 1898, the amount was increased to $25,000 in that year and the work was extended in 1901 to cover all mineral resources in Alaska, with an appropriation of $60,000, which was increased to $80,000 by 1905.

Similarly, the Survey had made investigations in Hawaii, Puerto Rico, and Cuba at an early date, and it continued to do so through Walcott's term.

This period marked the development of standardized geologic nomenclature with the organization of the Geologic Names Committee in 1899, with P. C. Warman as its first chairman. This important function of the Survey began in the Division of Geologic Correlation, established under Gilbert in 1888. Rules for geologic nomenclature and classification, published in 1890 (*33*), combined the minimum of regulation consistent with the orderly progress of geologic mapping and map publication. However, as mapping progressed and geologic folios were prepared, questions multiplied that were not covered by existing regulations, and decision on these, said Gilbert (*34*), "developed a system of precedents, analogous to the common law in distinction from statutory law." The regulations were therefore revised by the new committee, who took into account the opinions, suggestions, and criticisms of their colleagues, and were published in 1904 (*35*).

In 1904, the Survey celebrated its 25th anniversary by publishing a bulletin (*36*) describing its origin, development, organization, and operations. It gives a detailed picture of the Survey of that time. The permanent force had grown to 678 from 39 in 1879 and 135 in 1881. In a section of two and a half pages, the Survey evaluated the general results achieved in 25 years. It will be instructive to summarize them here.

Twenty-six percent of the area of the country including Alaska (31 percent excluding Alaska) had been topographically mapped and the results shown in 1327 atlas sheets printed in three colors from copperplate engraving.

Many of the broader problems whose solution was necessary to the "final geologic mapping of the country" had been solved. Geologic mapping of surface formations covered 171,000 mi², and 106 geologic folios had been published, with an equal number in preparation.

Important experiments and investigations into the physical characteristics of rocks in various processes of formation and of volcanic and geyser action had been conducted in the physical laboratory, and many important conclusions had been reached. The chemical and petrographic laboratories had been busy solving, chemically and microscopically, the more important problems connected with rock composition and structure, and the paleontologic section had done important work in solving stratigraphic and structural problems by the classification and identification of fossil plants and animals.

The engraving and printing division had engraved 1421 series of copperplates, each series consisting of three plates, one for each color. It had lithographed on stone the colors, ranging from 10 to nearly 30, necessary for distinguishing in each of about 100 folios the various formations and outcrops. It had printed several editions of most of the topographic maps and at least one edition of the geologic folios, and had engraved and printed miscellaneous state and United States maps.

In the preceding 15 years, the maximum, minimum, and mean discharges of all the important rivers of the United States had been recorded, together with those of the lesser tributaries for shorter periods. The physical characteristics of the river basins had been studied and a vast amount of data had been collected from which it was possible to estimate closely the volume of runoff of each stream. These data had contributed to the rapid development of water power. Data had been collected regarding irrigable lands and their relation to possible water supplies. Reservoir sites had been examined and surveyed, and the lands had been withdrawn from sale or occupation pending more detailed study.

Detailed examinations had been made of 110,000 mi², including classification of the lands, as forested (with the stand and kind of timber), grazing, desert, and cultivable, and final reports had been prepared on these reserves showing the kind and amount of timber and many other facts useful as a basis for future forest management.

Finally, the bulletin states (*36*):

> Perhaps the immediate value to the people of the work of the Geological Survey is best shown by the aid it extends in developing the mineral resources and in forwarding important engineering projects in which the people, as well as the State and Federal Governments, are interested. To instance a few cases: the work of the geologic branch has had a wide educational influence upon the public at large, but more directly upon those engaged in the mining industry. Among the many direct practical benefits which it has conferred upon this industry may be mentioned the investigation of the mining geology of Leadville, which has not only guided exploration and secured

economical mining in a district that has produced between $200,000,000 and $300,000,000, but has been of even more beneficial result in teaching the mining engineer and the miner the practical importance of geologic study in carrying on their work; in other words, it has greatly improved mining methods throughout the whole country. The investigation of the origin and geologic relations of the Lake Superior iron ores and the publication of numerous reports on that region have so effectively directed the prospector in the discovery of the deposits and the miner in economical methods of development that this region now leads the world in the production of iron ore. The detailed areal mapping and the determination of underground structure in the Appalachian coal field are placing the development of its coal, petroleum and gas resources upon a scientific basis and relieving those branches of the mineral industry of a large part of the hazard and uncertainty which has always hitherto been associated with them. The collection and publication of reliable statistics of mineral production have furnished a sound and commercial basis for all branches of the mineral industry.

Walcott had served as acting assistant secretary of the Smithsonian Institution in charge of the National Museum in 1906 while still director of the Survey, and in 1907 he was chosen to be secretary of the Institution, a position that he filled until his death in 1927. George Otis Smith (*31*) says:

> . . . he so administered that scientific bureau [the Survey], devoted to fact-finding and the coordination of facts and principles, as to serve both the Government and the people. "The public" as defined and served by Director Walcott included farmer, miner, landowner, and investor as well as student, teacher, and research specialist. He was prompt to see the need of research, both scientific and engineering, along varied lines and the growth in popular appreciation of the Geological Survey under Director Walcott is attested by the large increase in annual Congressional appropriations for the Survey work during his term of office.

Increased Usefulness of the Survey, 1907–30

On May 1, 1907, Secretary Garfield announced the selection of George Otis Smith to serve as the fourth director of the Survey. So, at the early age of 37, an able scientist and administrator was given the task of directing the organization that, in the words of Philip S. Smith in a memoir on George Otis Smith in 1944 (*37*), "had done so much to advance American science and that stood at the threshold of increased usefulness to the nation." Philip Smith's memoir is rich in details of George Otis Smith's activities and also those of the Survey during the period 1907–30, and we have relied heavily on his information in the material that follows.

George Otis Smith was born in Hodgdon, Maine, in 1871 and graduated from Colby College in 1894. He had been introduced to geology by Professor W. S. Bayley. It was probably at Bayley's suggestion that he went to Johns Hopkins University for graduate work in petrography and he received a Ph.D. degree there in 1896.

He immediately joined the Survey as an assistant geologist in a field assignment in the state of Washington under Bailey Willis. For the next 6 years he worked on assignments in various parts of the West and participated in the preparation of five geologic folios. In 1903 he was assigned to diverse investigations throughout New England, in much of which work he was assisted by E. S. Bastin.

By 1906 he had established himself as a geologist and a keen and well-balanced administrator and was selected to bear more and more details of office management and operation (for example, in 1906 he became geologist-in-charge of the section of petrography). When President Theodore Roosevelt appointed a commission to study Government administration and ways of improving procedures and reducing costs, Smith was made chairman of the special subcommittee on business methods of the Survey. Abolition of some old Survey practices and institution of new ones were a direct outcome of these studies which revealed Smith's ability to analyze problems and propose helpful solutions.

In the search for a successor to Walcott as director of the Survey, many geologists were considered and P. S. Smith (*37*) cites a letter on the subject from one of the deans of American geology in which George Otis Smith was characterized as

> . . . one of the ablest of the younger men but still too young for so great a responsibility. Ten or fifteen years hence he might be the best man but his appointment now would be regarded as premature by the great body of geologists.

Smith himself did not actively pursue the post and, indeed, is said to have been an ardent supporter of another man being seriously considered.

There were problems facing the new director. He was regarded as being among those who placed undue emphasis on so-called economic results as distinct from the theoretical aspects of geologic problems. P. S. Smith considered this a revolt against the leisurely way of some investigators in allowing their work to drag along for years without concrete results. The truth of the matter seems to be that George Otis Smith truly appreciated and encouraged basic research but sought to widen the Survey's usefulness in applied science. In fact, the Survey had come a long way on this path under its three preceding directors.

Under the new director, the Survey continued to grow, and a record of the next 23 years would be a long one. We have therefore chosen to describe only those events that seem to us to be of chief interest.

Early in this period, the conservation movement in the United States gained momentum, and it had its impact on the Survey. Smith and most of the Survey geologists took the middle ground that conservation meant wise use of the nation's natural resources without waste. President Roosevelt called a state governors' conference in Washington in 1908 to discuss conservation problems, and his successor, President

Taft, encouraged additional investigation. In these studies, the Survey played an important part in suggesting improvements in existing procedures, such as favoring the disposal of certain mineral lands through lease rather than by sale at nominal prices. In the ensuing controversies that developed between Gifford Pinchot and Secretary Ballinger, the Survey continued to support its own views, and improvements followed ultimately in the wiser disposal of public lands and in better leasing practices.

In 1908 a Land Classification Board was organized in the Survey, and the supervision of leasing operations was initiated in 1913 when the Bureau of Mines was charged with inspection of all mines belonging to Indians and Indian tribes. Passage of the Mineral Leasing Act in 1920 resulted in appropriations to the Bureau of Mines for public-land operations, and leasing supervision was transferred to the Survey in 1925.

Another expanded activity came to the Survey by congressional passage of the Potash Act, which directed the Survey to explore for deposits of potash. This act was in response to the monopoly that Germany had gained on the potash supply. In this program, Survey geologists studied many ancient salt deposits and modern-day saline playas and salt lakes. This led to the recognition of the importance of Searles Lake as a source of potash.

World War I brought new opportunities of service to the Survey. Most of the skilled topographers in the United States were members of the Survey, and many of them were commissioned for duty with the Topographic Corps of the Army or as artillery orientation officers. This led to increased interest of the Survey engineers in aerial photography and to rapid developments in photogrammetry, in which the Survey has played a leading part for 50 years.

Photogrammetry is defined in a recent Survey publication (*38*) as "the science or art of obtaining reliable measurements by means of photography," and is now used extensively for topographic mapping. It is an essential component of all large mapping operations.

Two members of the Survey, C. W. Wright and F. E. Wright, first used a panoramic camera for topographic surveys in 1904. C. W. Wright had a camera constructed especially for surveying purposes in 1907, and J. W. Bagley improved the camera for reconnaissance mapping in Alaska; he also designed a photoalidade. In 1916–17 he developed a tri-lens camera for aerial photography.

In the following year, the Survey cooperated with the Corps of Engineers and the Air Service in a program of photographing with the tri-lens camera strips of country between airfields for the purpose of making aeronautical charts. After the war, photogrammetry sparked revolutionary changes in surveying and mapping techniques under the leadership of C. H. Birdseye, J. G. Staack, and T. P. Pendleton.

World War I also saw the birth of the "strategic minerals" concept, which became important in World War II. Many of the Survey men made special investigations of certain mineral deposits, and exploration for new deposits was greatly increased. The backlog of scientific data in the Survey was essential to these activities. Domestic sources of mineral commodities were reexamined, and information on the potential mineral and water resources of other countries was gathered. Much of this information was published in the Survey's *World Atlas of Commercial Geology* (*39*); it had originally been prepared in manuscript form for the use of the State Department and the Peace Commission.

Following the war, George Otis Smith took the Survey into areas of expanded service. An example of this activity was the Superpower Survey of the Boston-Washington area. N. C. Grover of the Survey contributed to the technical phases of this study. The inquiry stemmed from a proposal made to Secretary Lane by E. G. Buckland of the New York, New Haven, and Hartford Railroad for a survey of the sources of energy in New England and on the Atlantic seaboard as far south as Washington. The great development of war activities had increased the demand for power, and Lane was sympathetic to the proposal. He called on the Survey to investigate and report. Congress appropriated $125,000 for the work, which was completed in 1921 and published as *Professional Paper 123* (*40*). This paper is regarded as an important contribution to engineering literature related to power supply and was useful in the interconnection of power systems in the country.

This work led to an increased consideration of power sources in the United States and awakened interest in the need for facts regarding the production, distribution, and use of coal. As a result, Congress established the Federal Coal Commission in 1922, whose duties were strictly fact-finding. John Hays Hammond was appointed chairman, with George Otis Smith as one of four other members. The commission was set up for 1 year, and Smith, convinced of its worth and being advised by the Attorney General that he could not serve while director of the Survey, resigned as director October 31, 1922, and was reappointed August 24, 1923.

These activities brought the Survey, or at least its director, into an increased advisory capacity on many matters dealing with natural resources, and this trend is still going on. Its method of discharging such duties is described by P. S. Smith (*37*) as "the long-established record . . . of keeping free of partisan entanglements and attending strictly to those technical matters on which the Survey could speak with authoritative finality."

In the early 1920's, a group of Survey publications appeared that illustrates one of its most important functions. This is the dissemination of data in the form of bibliographies and useful compendiums. Among these are F. W. Clarke's fifth edition of his *Data of Geochemistry*, appearing in 1924, which, now under revision, has been the basic work in this field (*41*); J. M. Nickles' bibliography of North American geology, 1785–1918, which is one in a long

line of such works (*42*); the first edition of *Microscopic Determination of the Nonopaque Minerals* of E. S. Larsen, Jr., (*43*) which formed a systematic basis for the determination of nonopaque minerals under the microscope and which was enlarged in a second edition in 1934; O. E. Meinzer's report on the occurrence of ground water in the United States, with a discussion of principles, in 1923 (*44*); E. C. LaRue's work on water power and flood control of the Colorado River below Green River, Utah, in 1925 (*45*), prepared as a result of a Survey expedition through the canyons of the Colorado River in 1923; and E. M. Douglas' work on the boundaries, areas, geographic centers, and altitudes of the United States and the several states in 1923 (46), a publication which evolved from three earlier ones by Henry Gannett in 1885, 1900, and 1904, and which went into a second edition in 1930. The monumental earlier work of H. S. Washington, a compendium of the chemical analyses of igneous rocks published from 1884 to 1913, which appeared in 1917 (47) and is now under revision, should also be mentioned.

In 1929, when the Survey reached its first half-century, the occasion was marked in the 50th annual report of the director by a statement, under the heading "Fifty years of service," which reads, in part, as follows (*48*):

> In the first half century that has passed . . . the Geological Survey has grown in stature, widened its field of endeavor, and increased its usefulness, but it has not grown old. . . . The far-reaching outlook of specialized public service that is possessed by many men in high positions in this country is a by-product of the United States Geological Survey.
>
> During this half century the Federal funds made available for the work of the Geological Survey have increased from $100,000 to more than $2,000,000. The total expenditures for the 50 years have been $75,000,000 of which nearly $10,000,000 has been contributed by States for cooperative work. Most of the work on which these millions have been expended may be described by the simple term "fact finding." The Geological Survey has been continuously engaged in research—in bringing to light facts that have been of essential importance in the marvelous development of our country since 1879. When the Geological Survey made its first census of mineral production, the treasure house of the country had hardly been opened; since then the mineral industry has increased fifteenfold. The research work of the Geological Survey has not been confined to investigations whose immediate economic value is self-evident. Realizing that the pure science of today becomes the applied science of tomorrow, it has neglected no phase of the study of the earth. Its method of work and the men it has trained have powerfully shaped the course of development of the science of geology.
>
> The topographic maps that have been necessary to provide an accurate base upon which to represent the facts ascertained by the geologic work have now attained so high a degree of exactness that they are sought for themselves by all classes of the people—from engineer to vacation tourist. The investigations of water, our greatest mineral resource, have thrown light on the complex problems of public water supply, inland navigation, flood prevention, reclamation by both drainage and irrigation, and the development of power. The activities of the Geological Survey in respect to the vast mineral estate comprised in the public land, of which nearly 200,000,000 acres still remain unappropriated, have been based on the practical policy of planning for its future use without waste of the resources and for the intelligent distribution of that use as to time—between our day and our children's day.
>
> Not the least of the accomplishments of the Geological Survey during its first half century has been its service as the mother of other organizations that are playing essential parts in the study of our country and the development of its resources. The work that is being done by the Bureau of American Ethnology, the Forest Service, the Bureau of Reclamation, the Bureau of Mines, and the Geophysical Laboratory of the Carnegie Institution had its beginnings in the Geological Survey.
>
> The publications by which the results of the multiform investigations of the Geological Survey have been made available in permanent form now comprise more than 400,000 printed pages and occupy 120 feet of shelf room—twenty-four "5-foot shelves" of recorded facts and conclusions concerning the unequaled natural resources of the United States.

The Survey had grown to 998 permanent employees, and its annual expenditure, including state funds, for fiscal year 1929 was $3,875,000.

In 1930 George Otis Smith was asked by President Hoover to serve as chairman of the newly formed Federal Power Commission, and, after giving the matter considerable thought, he resigned the directorship of the Survey on December 22, 1930. His term as director was marked by unswerving official integrity and the practical application of science to the public welfare.

The Survey in Peace and War, 1930–43

W. C. Mendenhall became acting director of the Survey when George Otis Smith resigned and full director in 1931.

Born in Marlboro, Ohio, in 1871, Mendenhall graduated from Ohio Northern University in 1893. He studied at Harvard in 1896–97 and at Heidelberg in 1899–1900. He joined the Survey in 1894 as an assistant geologist, becoming geologist in 1901. His first work was in Alaska on a variety of assignments, and in 1903 he was placed in charge of the Los Angeles Basin ground water investigations. His work was the first application of stream flow records in the solution of ground water problems. In 1908 he became geologist-in-charge of the Ground Water Branch, continuing in this post until 1912, when he became chief of the Survey's Land Classification Board, a post he held until 1922. He became chief geologist in that year and acting director in 1930. He thus brought to the directorship sound scientific ability and wide administrative experience in a diversity of Survey activities.

The depression of the early 1930's was in full swing when Mendenhall took over. Painful adjustments be-

came necessary in fiscal year 1934, and many separations from the service were made with accompanying suspension of many projects. At the same time, however, the new agencies and services of the Government made so many and varied demands on the Survey that its specialists and their specialized knowledge were at a premium. The situation, however, was relieved by the allocation of funds from such agencies as the Public Works Administration that absorbed the available engineers and allowed the hiring of many hundreds of unemployed technical men, all on projects concerned with topographic mapping, suppression of mine fires, and plugging of abandoned oil wells in the public domain, as well as a survey of some of the more important mineral resources of the eastern and southern states. The pattern for the next few years was one of curtailed direct appropriations, but large allocations from other agencies made up the difference. However, in fiscal year 1936, the Survey was able to report that, because of a better fiscal situation, it was possible to resume more normal operations and to issue a large number of Survey products, as the publication of 50 reports and 281 topographic and other maps demonstrated. A similar number was issued in fiscal years 1937 and 1938.

When the Tennessee Valley Authority was established in 1933, it became immediately necessary to provide map coverage of the entire valley. In cooperation with TVA, the Survey agreed to prepare planimetric maps of the region and was able to do so by the application of photogrammetric methods. In 1935, the Survey bought its first multiplex equipment. The value of this method was successfully demonstrated, leading to the establishment of a fully equipped multiplex mapping office in Chattanooga, with a program of topographic mapping of the entire Tennessee River Valley in cooperation with the TVA. A variety of mapping work was done for other Federal agencies during these years.

In 1933, the XVI International Geological Congress was held in Washington and the Survey's new geologic map of the United States, in preparation for many years, was hastened to completion for the event (*49*). In four sheets, at a scale of 1:2,500,000, it has been in great demand, but such is the progress of geologic investigations that it is now in need of revision.

With the threat of approaching war, Congress appropriated $150,000 to the Survey in 1939 and authorized the same sum for the next 3 years to be used for strategic minerals investigations. When the war broke, however, these sums were greatly increased. Strategic minerals investigations had become a normal function of the Survey in World War I, and it was natural that the Survey should be called upon to provide its know-how in this highly critical field in World War II. Expansion of this work was limited only by the number of available qualified men. Almost the entire personnel of many of the Survey sections were shifted to this work.

In fiscal year 1941, the Survey was called upon by the Committee for Cooperation with American Republics to undertake examinations of certain strategic mineral deposits in a number of Latin American countries. This work assumed increasing importance during the war and was eventually sponsored by the Department of State.

In February 1942, a military geology group was formed in the Survey and grew very rapidly as its work became more and more useful to the Armed Services. Its function was to supply reports and maps on many areas in response to requests from the Intelligence Branch of the Army Engineer Corps, Air Forces, Naval Intelligence, Board of Economic Warfare, Engineer Board at Fort Belvoir, and Army and Navy Munitions Board.

Director Mendenhall had prepared the Survey for war service and, having passed the normal retirement age, was ready to retire after a long and distinguished career in the public service. He had steered the Survey through a most difficult period. The Survey and the nation owe him profound gratitude for his magnificent performance.

The Survey in War and Peace, 1943–

W. E. Wrather came to the directorship of the Survey from outside its ranks, although he was not entirely a stranger to its rolls, having worked for it as a field assistant in 1907.

Born in Brandenburg, Kentucky, in 1883, he graduated from the University of Chicago in 1908. He was a geologist with the Gulf Products Company and the J. M. Guffey Petroleum Company from 1908 to 1916. He was an independent consulting geologist from 1916 to 1942. He became associate chief of the Metals and Minerals Division, Board of Economic Warfare in 1942 and director of the Survey May 7, 1943.

When Wrather came to the Survey, it had begun a phenomenal growth which has continued to the present time. For fiscal year 1943, the expenditures of the Survey were more than $11,000,000, representing funds directly appropriated to it by Congress, supplied to it by cooperative agreement from various states and other governmental units, and transferred to it from other federal agencies. Every year since then these over-all funds have increased, and the resulting growth of the Survey has presented a variety of administrative problems. That the Survey has functioned well during this time is a tribute to Wrather's leadership.

During World War II, the Survey's resources were wholly devoted to the war effort. Military geology functions grew to great proportions. In addition to the work of this group, as previously described, it appraised the characteristics of enemy terrain for the Corps of Engineers from published geologic reports and maps. Soil scientists from the Department of Agriculture worked with the geologists in these appraisals, which were used for strategic planning. Later, Survey geologists went into the war theaters as civilian specialists and were able to aid in planning tactical operations. Since the war, the military geology group has remained an important part of the

Survey in continuing a variety of services for the Defense Department.

There was a tremendous expansion of mapping needs during World War II, and the Survey placed all of its map-making factilities and personnel at the disposal of the Armed Services. The period between the two world wars had been one of somewhat slow progress in mapping. The Temple Act passed by Congress in 1925 had called for a 20-year mapping program to finish the topographic map of the United States, but sufficient funds were not made available to carry out the schedule. At the end of World War I, it was considered that 45 percent of the United States was adequately mapped, but by World War II only about 20 percent met modern-day standards.

The impact of World War II stepped up the mapping program, more funds were made available, and map production has correspondingly increased. This is illustrated by the fact that 5000 separate topographic quadrangle maps were produced during the first 60 years of the Survey's existence and 8000 during the last 15 years. In fiscal year 1953, more than 1300 such maps were produced, and the present rate is 1500 a year. By the end of fiscal year 1953, about 30 percent of the United States was covered by maps of good quality. Much of the mapping in late years, because of the high priority of the defense mapping program, has been in areas of military needs, but more federal mapping can be started in areas of more general mapping needs when the military demands recede. Methods and techniques in use today are responsible for the production of maps that are better and less expensive and are appearing at a faster rate.

Under current mapping programs, new mapping or revision is going on in all the states, and in Alaska, Hawaii, Puerto Rico, and the Virgin Islands. The National Topographic Map Series consists of 7½-min quadrangle maps at a scale of 1:24,000, 15-min quadrangle maps at a scale of 1:62,500 and reconnaissance maps at a scale of 1:250,000.

The production of geologic maps should be materially increased by the use of photogrammetry in this type of mapping, and the Survey is actively pushing this application.

Water resources investigations have also increased and at present, for instance, the Survey is operating more than 6000 stream-gaging stations. A distinctive feature of these investigations is the extensive cooperation with federal and state agencies. The proportions of the total effort at present are 55 percent federal-state cooperation (on a 50-50 basis), 22 percent cooperation with other federal agencies, and 23 percent Survey. Data collected by the Survey are basic to the extensive federal interagency work in various river basins, and in this Survey effort the water resources investigations play a leading role. As water supplies for all purposes become increasingly critical in the United States, the systematic recording of water data of all kinds by the Survey insures that the basic facts are available when needed.

Conservation work in the Survey also has increased since 1943 and continues to increase. Since the beginning of mineral-leasing activities on public lands in 1920, up to 1952, the latest year for which complete figures are available, about $323,000,000 has accrued in royalties. By statute, 52½ percent of such royalties go to the Federal Reclamation Fund, 37½ percent go to the states where the minerals were produced, and the remaining 10 percent go to the United States Treasury. As of June 30, 1953, the Survey was supervising 1261 mining properties under leases, permits, and licenses in 27 states and Alaska. Annual production from such lands amounted to about $120,000,000. In addition, 78,785 oil and gas properties were under lease. These are examples of the extent of such work.

In its mineral classification work during the fiscal year 1953, the Survey handled 19,259 cases, and in its water and power classification work, it added 18,926 acres to power-site reserves and eliminated 2244 acres, increasing the outstanding reserves in 23 states and Alaska to a net total of nearly 7 million acres.

With the development of atomic energy, the Manhattan Engineers District Project and later the Atomic Energy Commission called on the Survey for a major effort in fissionable raw materials investigations. This has now become a large program in the Survey and has materially contributed to the nation's increasing inventory of such materials. The Stockpiling Act of 1950 has also involved the Survey in great responsibility for implementing the programs of the Defense Minerals Exploration Administration and the Defense Procurement Agency. The Survey in late years has also been called upon to undertake geologic investigations of mineral resources in underdeveloped countries under the Mutual Security Act and to serve as advisors and consultants to the National Security Resources Board, the National Science Foundation, and the Department of Defense. It is keenly aware of the need for continual improvement of techniques for exploration for mineral resources; and its development (in cooperation with the Navy) and successful use of the air-borne magnetometer, the development and successful use of air-borne radioactivity methods, the development and successful use of geochemical prospecting, and other related activities testify to its efforts in this field.

Today the Survey has more than 6000 permanent employees. It distributes nearly 2,500,000 maps and 225,000 book reports annually. It expends about $48,000,000 a year in funds from all sources, and in 75 years the grand total of such expenditures has been about $475,000,000. It has published about 3000 book reports and probably an equal or greater number of such reports in technical, scientific, and popular journals, and it has published about 15,000 different maps.

Its professional people through the years have won many honors in scientific circles and have served as officers in many scientific and technical societies. The whole Geological Survey is aware, with Director Wrather, of the great responsibility it bears in continuing to serve the nation in the years ahead. But there is much to be done and, as George Otis Smith

said at the beginning of the Survey's 51st year, "The one hundredth report of the Director of the United States Geological Survey may be expected to be simply a report of progress."

It seems appropriate to close this episodic history of the Geological Survey with the words of a dedication by Emmanuel de Margerie, which appeared in his *Etudes Americaines, Geologie et Geographie* (Librairie Armand Colin, Paris, 1952).

A LA GLOIRE DES MEMBRES DE
L'UNITED STATES GEOLOGICAL SURVEY
dont la féconde activité, au cours du dernier
siècle, a révélé,
dans l'Ouest du Territoire
tant de faits nouveaux et importants pour la Science

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News and Notes

Fourth Rochester High-Energy Physics Conference

The fourth in the annual series of conferences on high-energy nuclear physics initiated by R. E. Marshak, chairman of the Rochester physics department, and sponsored jointly by a group of local industries and the National Science Foundation, was held on Jan. 25–27. The conference chairman this year was J. B. Platt. About 75 representatives of American and European laboratories actively engaged in high-energy physics and cosmic-ray research attended the sessions. Attention was focused on the fundamental experimental and theoretical problems of nucleon-nucleon, meson-nucleon, and photon-nucleon interactions and the various unstable particles found in the cosmic radiation and now also produced artificially by the Brookhaven cosmotron.

J. R. Oppenheimer (Institute for Advanced Study) presided over the opening session on nucleon-nucleon scattering, polarization, and π-meson production. Ashkin (Carnegie Tech) reported on the differential p-p scattering cross section at 437 Mev measured by Sutton and Fox which shows a rise at small angles, in disagreement with results at Chicago; the discrepancy seems to arise from different methods of correcting for the process $p + p \rightarrow \pi^+ + d$. The n-p differential cross section at 400 Mev measured by Hartzler and Siegel at Carnegie Tech (reported by de Benedetti) shows the same asymmetry about 90° found at lower energies. Pickavance (Harwell) reported that R. Wilson's n-p measurement at 102 Mev confirmed the older symmetric results at 90 Mev, but by 133 Mev, this symmetry is disappearing.

Oxley (Rochester) summarized the original experiments showing strong polarization in 230-Mev proton scattering in hydrogen and several other elements. These are now confirmed at 150 Mev (Dickson and Salter, Harwell), 337 Mev (J. and L. Marshall, Chicago), 330 Mev (Chamberlain and Segrè, Berkeley).

The later experiments also give the angular distribution of the polarization and are in agreement. What is not yet clear is the relative importance of elastic, quasi-nucleon, and inelastic contributions to the polarized scattering from complex nuclei. In striking contrast, the polarization in p-n-p scattering at 340 Mev (Bradner, Berkeley) and 240 Mev (Hafner, Roberts, and Tinlot, Rochester) is only about 5 to 10 percent. Breit (Yale) noted that while the unpolarized nucleon-nucleon data could be fitted by S and P phase shifts alone, the angular distribution of the polarization as analyzed by L. Marshall requires the presence of at least F waves as well. The hard core singlet potential model explains the p-p angular distribution but has too weak noncentral forces to fit the polarization, whereas the singular tensor force model, which fails for the angular distribution, gives the right order of magnitude of polarization. Carnegie Tech results on $p+p \rightarrow \pi^+ + d$ at 437 Mev extrapolate to give agreement with earlier measurements at Columbia of the inverse process. Moyer (Berkeley) reported recent results on $p+d \rightarrow He^3+\pi^0$ that are compatible with the charge independence requirement that they be one-half of the corresponding area section for the process $p+d \rightarrow H^3+\pi^+$, but do not yet prove that it holds. Thorndike (Brookhaven) reported that for 1 to 2.2 Bev n-p collisions, two π mesons are produced much more often than one, whereas the statistical theory of production would predict the reverse situation. Brueckner (Indiana) showed that interactions between the nucleons in the final state could possibly account for the discrepancy.

W. K. H. Panofsky (Stanford) chaired the experimental session Monday afternoon. Rainwater (Columbia) reported on extensive work on the Z dependence and fine-structure splitting of K x-rays from μ-mesic atoms, which is giving information about charge distribution in heavy nuclei comparable to that obtained from high-energy electron scattering. De Benedetti (Carnegie Tech) has measured both K and L x-rays in low Z π-mesic atoms and finds a puzzling depression of the L radiation at low Z. Platt and Camac (Rochester) agree with the x-ray results for $Z > 6$ but think that discrepancies at lower Z may be due to neglect of the correction for escape of quanta from the detecting crystal. Lederman (Columbia) has measured the μ decay spectrum giving $\rho = 0.64 \pm 0.09$ ($m_\mu = 207.0\ m_e$). He has also looked at internal conversion gamma rays from π^- mesons stopping in hydrogen arising from the two processes $\pi^- + p \rightarrow n + \pi^0$ and $\pi^- + p \rightarrow n + \gamma$ and obtains results in agreement with theory. Stinberger (Columbia) is making a direct measurement of $\pi^- + d \rightarrow 2n$. Moyer (Berkeley) had a proposed method for a direct measurement of the π^0 lifetime. R. Walker (Cal Tech) and Bernardini (Illinois) discussed the calibration of bremsstrahlung from electron synchrotrons. Strauch (Harvard) showed that 97-Mev protons on complex nuclei undergo inelastic processes which exhibit a definite level structure.

The separate theoretical session was presided over by G. Wentzel (Chicago). Goldberger (Chicago) attempted to show that the currently fashionable PS-(PS) meson theory is in disagreement with experiment. His procedure is to calculate *rigorously* (in the limit of vanishing external meson mass) the cross section for meson-nucleon scattering at zero energy and, thus, evaluate the coupling constant. This coupling constant being small, he then evaluates the photomeson production cross section at threshold by perturbation theory and cannot reproduce the experimental results. Unfortunately, experimental results presented at this conference indicate that the former process is probably larger than had been thought and, therefore, prevents strict conclusions being drawn. Källén (Institute) objected on theoretical grounds that if any process (such as photomeson production in this case) leads to a large coupling constant, no perturbation expansions are valid even if another method of determining the coupling constant leads to a small value. Lévy (Paris) presented an attack on the problem of removing divergences that arise from iteration of the meson-nucleon scattering equations. Wick (Carnegie) outlined a promising approach to the relativistic two-body bound-state problem. Klein (Harvard) and Feldman (Rochester) pointed out certain errors that have been made in the application of the Tamm-Dancoff method. Feldman particularly stressed that in most calculations so far carried out on the nuclear-force problem, this method is no improvement on weak-coupling perturbation theory. Brueckner (Indiana) indicated that the PS(PV) potential with core that fits the two nucleon data can possibly also lead to the saturation of nuclear forces.

At the Tuesday morning session, the chairman, C. D. Anderson (Cal Tech) summarized the results of the Duke conference on the present status of hyperons (Λ^0, Λ^+, Ω^-) and K-particles (τ^+, θ^0, κ, χ). Leprince-Ringuet (Paris) presented evidence for a new particle of mass about 913 m_e which decays to a μ meson of apparently unique momentum 220 ± 3 Mev/c, and a single light neutral particle. Kaplon (Rochester), Reynolds (Princeton), Klarmann (Rochester) Goldhaber (Brookhaven), and Crussard (Rochester) presented cases of K-particle decay and interaction, of artificially produced particles in the last two instances. Hyperon and θ^0 decays were presented by Thompson (Indiana), Fowler (Bristol), Thorndike (Brookhaven), and Anderson. Fowler also has evidence for the production in high-energy events of particles of mass around 1400 m_e which seem distinct from most observed K-particles. Crussard has an event that is interpretable as a hyperon replacing a nucleon in an α-particle, and Primakoff (Washington, St. Louis) discussed calculations of the branching ratios for decay of such hyperon-nucleon combinations. Dalitz' (Cornell) analysis of momentum distribution in τ decays may soon eliminate the possibility of an alternative two-π decay mode for this particle as more data become available. Wheeler (Princeton) presented calculations undertaken to assess the possibility that a single particle of mass about 960 m_e could explain the existing data as alternative decay modes.

E. Fermi (Chicago) presided over the Tuesday afternoon session on pion problems, which was continued Wednesday morning under the chairmanship of H. A. Bethe (Cornell). Total cross sections for $\pi^- + p$ interaction from 133 to 258 Mev and $\pi^+ + p$ from 128 to 182 Mev were reported by Ashkin (Carnegie); they exhibit a strong maximum around 200 Mev, and the fact that σ^+ is very closely $3\sigma^-$ favors the interpretation of this as a resonance in the state of isotopic spin 3/2. Brookhaven experiments have extended our knowledge of these two cross sections to 1.5 Bev, as reported by Yuan and Piccioni. The most interesting feature is a maximum in σ^- around 1 Bev of about twice the value found for σ^+; this is very suggestive of a strong interaction in the state of isotopic spin ½ at this energy. Thorndike (Brookhaven) has cloud-chamber results indicating that perhaps 2/3 of σ^- is inelastic at high energy. W. D. Walker (Rochester) at the same energy finds perhaps an even larger proportion of inelastic events and an interesting tendency for rather small momentum transfers in the collisions. Yuan (Brookhaven) has preliminary results on the energy spectrum of πs produced from Be as a function of the incident proton energy. Roberts (Rochester) has obtained an angular distribution of the 40-Mev π^- charge exchange scattering in hydrogen which, together with Barnes' previous results on charged meson scattering, allows a determination of the phase shifts. Coulomb interference at this energy allows in principle a determination of the absolute signs of the phase shifts, but present inaccuracies allow an alternative set to that preferred by the theorists. Bernardini (Illinois) has pushed the determination of the photoproduction cross section for π^+ from hydrogen close to threshold, and his results show that the energy variation of the pion-nucleon-scattering phase shifts below 40 Mev cannot be linear. R. Walker (Cal Tech) reported two independent experiments on the angular distribution of this cross section from 250 to 500 Mev and also for neutral meson photoproduction at two angles over the same energy range.

Bethe (Cornell) discussed the phase-shift data on pion-nucleon scattering now available, showing that a set acceptable to the theorists could be found, and suggesting experiments to distinguish it from other sets. He reconciles the low-energy photomeson and scattering data by an extrapolation procedure that is qualitatively similar to the predictions made by an S-wave potential model presented by Noyes (Rochester). Very tentative results at 5 Mev support this idea, but equally uncertain results on D waves at 217 Mev would tend to invalidate the high-energy analysis. Rarita (Brooklyn College) discussed the data in terms of a one-level resonance formula. Sachs (Wisconsin) presented a phenomenological model for the meson-nucleon system that seems to possess the right qualitative features to give the "observed" phase shifts. Chew (Illinois) showed that his weak-coupling, extended source model, which fits the p-wave scattering, may also prove capable of explaining photomeson production correctly.

A comprehensive report on this conference, prepared by H. P. Noyes, E. M. Hafner, J. Klarmann, and A. E. Woodruff, is available through the department of physics, University of Rochester.

H. P. Noyes

University of Rochester
Rochester, New York

Science News

In the face of a serious decline in the number of graduate students in science, **the draft** is now putting specialists into the army immediately upon their receiving undergraduate degrees. This situation, highly dangerous to the future supply of scientists and engineers, is discussed by Howard A. Meyerhoff, executive secretary of the Scientific Manpower Commission, Washington, D.C., in the June issue of *The American Psychologist,* which is published by the American Psychological Association.

The draft will come to mean that every able-bodied male of military age who is not in service or in the ministry will be selected for service, Dr. Meyerhoff warns. Since May 1, 1953, local draft boards have been taking graduation from college as their clue to reclassify recipients of the bachelor's degree. Graduates lose their deferment, even though they may go on to graduate work with scholarships and fellowships in many cases actually awarded by the government itself. First-year graduate enrollment dropped to 8000 in the academic year 1952–53, whereas it was 11,721 in 1951–52. The mortality during the summer months was especially severe, and many departments found themselves without graduate assistants when classes started in September.

National Science Foundation fellows and Office of Naval Research and Atomic Energy Commission research assistants were prominent among the casualties, as revealed by a sample survey of 34 departments in 19 institutions. This spot check, which was made in October, indicated that more than 2000 advanced graduate students had been inducted without regard to the status of their work.

The disregard of the best and most disinterested educational judgment and advice can be substantiated by innumerable specific cases, Dr. Meyerhoff declares. Selective Service has virtually taken over our system of graduate instruction in science, he charges. It has drastically cut the number of students, and is thus disrupting the supply and the flow of carefully selected manpower into fields where there are already disturbing shortages. It is seriously impairing the effectiveness and the pattern of instruction at the undergraduate, as well as the graduate level. It is pursuing a course that runs counter to the advice of the scientists from whom it sought advice, and counter to the national welfare as the Department of Labor sees it. It is depriving the Armed Forces of people with highly specialized training, insofar as there is a need for such men in uniform. It is, however, a real benefactor to foreign students, who, of dire necessity are being hired, according to Roger Adams of the University of

Illinois, to fill 50 to 75 percent and more of the vacant graduate assistantships.

The completion of **The American Museum of Natural History's Hall of North American Mammals** was marked by a combination preview and dedication ceremony on May 18. The Hall was conceived more than 20 yr ago to serve as an enduring representation of the mammals of this continent and as a demonstration of the importance of conserving our natural resources. However, it is not only a display of animals and scenic grandeur, but is also a hall of North American ecology, with botany, geology, topography, climatology, and all of the other environmental factors receiving the utmost attention.

The 29 habitat groups exhibited are the result of approximately the same number of expeditions to all parts of North America, and of the combined energies and talents of scientists, artists, preparators, and technicians—all of whom worked under the guidance of Harold E. Anthony, chairman of the Department of Mammals.

The first systematic archeological **survey of Catalina,** California's famous island, has been begun by Clement Meighan, in charge of the survey, E. V. Winans, and J. C. Hurst—all of the University of California at Los Angeles. Although the island resort is known to contain an abundance of Indian relics, no one has attempted to find out about the Indians who inhabited the island prior to the first Spanish visitors in 1542.

The Federal Civil Defense Administration, Washington, D.C., is exhibiting a prototype of its new **200-bed civil defense hospital.** The improvised hospital provides all equipment necessary to give rapid bed care to 200 disaster victims. It furnishes a casualty classification room, three operating rooms, shock treatment room, x-ray room with portable generator and transformer, laboratory, pharmacy, and wards. Completely mobile, it can be moved in a single van, set up at the disaster scene in any available building, such as a school, and can be in full operation 4 hr after arrival. States and cities may obtain the hospital through the Armed Forces Medical Procurement Agency for $26,435 on a matching fund basis with the Federal Government paying half the cost.

The American Telephone and Telegraph Company has announced that **Bell System patented inventions,** including the transistor, may be used without payment of royalties by American manufacturers of hearing aids. The Bell System offer is being made to hearing aid companies by letters from Western Electric.

The **Giauque-Kelvin temperature scale proposal**—the defining of the number system of the absolute, thermodynamic (Kelvin) temperature scale by assigning a number to the triple point of water as a single fixed point—probably will receive further consideration by the Commission on Symbols, Units, and Nomenclature of the International Union of Pure and Applied Physics at the coming meeting of the Union in London, July 8–10. Adoption of the proposal was recommended in 1948 by the Union and by the International Committee on Weights and Measurements, and in 1953 by the International Union of Pure and Applied Chemistry.

All that is needed to complete the adoption and to get the definition into use is approval, by the International Committee and the International Conference on Weights and Measures, of a defining number for the triple point. A National Research Council ad hoc committee has recommended that this number be made 273.170, which is the average of the recent experimental determinations of the triple-point temperature in several different countries.

The advantages claimed for the Giauque-Kelvin definition are: (i) the triple point offers greater precision than the ice point as a thermometric fixed point because as ice melts it surrounds itself with pure water, thus preventing intimate contact between the ice and air-saturated water; (ii) calibrations at the steam point, which are relatively more difficult and inaccurate, become unnecessary; (iii) the relation between the triple point of water on the Celsius (international) scale (0.010°C) and on the new scale will be fixed by definition; (iv) the probable errors in the "best" values for the gas constant R and the Boltzmann constant k can be reduced. The adoption of the proposal will in no respect affect the practical Celsius (international) scale, since the latter has its own independent definition based on six fixed points.

That a single fixed point, rather than two, be used to define the number system for the thermodynamic scale was proposed by J. P. Joule and Lord Kelvin in 1854, but was forgotten until W. F. Giauque, of the University of California, made it anew in 1939.

Scientists in the News

Robert F. Bacher, chairman of the Division of Physics, Mathematics and Astronomy at the California Institute of Technology, has been named acting dean of the faculty in the absence of **Dean E. C. Watson,** professor of physics, who is spending a year's leave in travel and research in Europe. Though Dean Watson has taken shorter trips, this is his first extended leave in the 35 yr since he joined the Institute faculty as an assistant professor in 1919.

The Maryland Branch of the Society of American Bacteriologists has made the following annual awards:

Werner Braun of Camp Detrick, the Barnett Cohen Award for his work on bacterial variations.

Marie H. Creel of the Maryland State Department of Health, the J. Howard Brown Award for her work on the detection of tubercle bacilli.

Thomas H. Brem, chief of the medical service of the Long Beach (Calif.) Veterans Administration Hospital for the past 5 yr, has been appointed director of clinical teaching and professor of medicine in the University of Southern California School of Medicine.

S. Stephen Chapman, instructor in the Department of Bacteriology and Immunology at the Harvard Medical School, has been appointed associate professor of microbiology in the University of Louisville School of Medicine, effective July 1.

The National Association of Corrosion Engineers' 1954 awards are as follows:

Irving A. Denison, known for his research in soil corrosion, the Willis Rodney Whitney Award in recognition of contributions to corrosion science.

E. H. Dix, Jr., whose contributions to better understanding of corrosion processes in aluminum and magnesium alloys date from 1919, the Frank Newman Speller Award for his achievements in corrosion engineering.

Lloyd Espenschied, coinventor with Herman A. Affel of the coaxial cable system, one of the major methods of transcontinental telephone and television transmission, has retired from the Bell Telephone Laboratories after 44 yr with the Bell Telephone System. A pioneer in the development of both wire and radio communications systems, Mr. Espenschied has been granted more than 100 patents for his inventions. He invented the radio altimeter, which foreshadowed the development of radar.

L. Kraeer Ferguson, professor of surgery at the Woman's Medical College of Pennsylvania, was recently guest lecturer at the Medical School of the University of the Dominican Republic on the subject, "Signficance of polypi in the colon." He was subsequently made an honorary member of the Asociación Médica Dominicana.

In April the Western Society of Engineers presented **Lillian Moller Gilbreth,** psychologist, research scientist, and industrial consultant, with the Washington Award for leadership in engineering. She is the first woman to receive the honor, which has previously had such recipients as Herbert Hoover, Orville Wright, Henry Ford, Arthur H. and Karl T. Compton, Charles F. Kettering, and Henry T. Heald.

Dr. Gilbreth, who lives in Montclair, N.J., is the widow of Frank B. Gilbreth. The Washington Award Commission has credited the Gilbreths with having set the trend in industry and architecture toward labor-saving techniques and design. Dr. Gilbreth is also well known as the mother of the large family described in the book, *Cheaper by the Dozen.*

Carlos Luis Gonzales, chief of the Division of Public Health of the Pan American Sanitary Bureau, Regional Office of the World Health Organization, has been appointed to the post of assistant director. Dr. Gonzales left the Venezuelan National Health Service, where he was director of public health, in August 1953 to join the staff of the Bureau.

George R. Harrison, dean of science at the Massachusetts Institute of Technology, received the award of the Society for Applied Spectroscopy at its annual meeting in May.

Clarence Lester Hogan, formerly of the Bell Telephone Laboratories, is now associate professor of Applied Physics in the Division of Applied Sciences at Harvard University.

At the annual meeting of the Society of American Bacteriologists, **Rollin D. Hotchkiss,** an associate member of the Rockfeller Institute for Medical Research, was presented with the $1000 Commercial Solvents Award for Outstanding Research in Antibiotics. Dr. Hotchkiss received the honor for his investigations on the basic mechanisms of antibiotic resistance and susceptibility in microorganisms. He worked principally with *Diplococcus pneumoniae,* the organism causing lobar pneumonia. One area of information resulting from his studies suggests that factors other than those in the antibiotic itself may influence the specific susceptibility or resistance to antibiotics by the microorganism. Dr. Hotchkiss's studies also constitute an important contribution to bacterial genetics, since they demonstrate that something in the nature of genetic linkages to other transforming substances may occur within the bacterial world. He was commended for "the fundamental nature of his investigations, the far-reaching biologic implications of the findings and the elegance of the experimental approach."

Morris S. Kharasch, University of Chicago chemist, has been named the first Gustavus F. and Ann M. Swift distinguished service professor of chemistry at the university. The professorship was established under the will of the late Charles H. Swift as a tribute to his father, the Chicago packer who helped to found the university, and to his mother, who was one of the university's greatest financial contributors.

In April, **Hans A. Krebs,** professor of biochemistry, Sheffield, England, presented a series of four lectures and conducted a number of seminars as visiting professor of physiological chemistry at the University of Wisconsin.

Thomas J. Killian, chief scientist of the Office of Ordnance Research, U.S. Army, at Durham, N.C., has been appointed dean of the School of Engineering and Architecture at the Catholic University of America.

R. Bruce Lindsay, Hazard professor of physics and chairman of the department at Brown University, has been named dean of the Graduate School, effective July 1.

Donald B. MacMillan, well-known explorer, has received the Bowdoin Prize of Bowdoin College in recognition of his Arctic explorations.

For inventing a way to detour excessive current due to lightning or other causes of short circuits on electric power lines and thus protect vital electric capacitors from damage, **Ralph E. Marbury,** engineer for

Westinghouse Electric Corporation, Pittsburgh, has received a $5000 "outstanding invention" award from his company.

On July 1, **Sedgwick Mead,** now associate professor and director of the Department of Physical Medicine at Washington University and director of the Department of Physical Medicine at Barnes Hospital, St. Louis, will become medical director of the California Rehabilitation Center at Vallejo. Sponsored by the Kaiser Foundation, the Center conducts the nation's largest nongovernmental program devoted to the neuromuscular rehabilitation of children and adults handicapped by various types of paralysis.

At the 50th annual meeting of the Society of Experimental Psychologists, Inc., **Neal E. Miller** of Yale University was awarded the Howard Crosby Warren Medal "for his distinguished contributions to the scientific investigation of the relationships between learning and emotional behavior, leading to an increased understanding of the development and fixation of emotional attitudes."

Herbert B. Nichols, information officer for the U.S. Geological Survey since 1949, has accepted appointment as manager of public information at the General Electric Research Laboratory, Schenectady.

Aura E. Severinghaus, associate dean, Faculty of Medicine, Columbia University, recently received the first Alpha Epsilon Delta Distinguished Service Award, consisting of a medal and citation, for his outstanding contributions to premedical education. Dr. Severinghaus and his colleagues conducted a survey of pre-professional education and published findings in *Preparation for Medical Education in the Liberal Arts College,* providing a body of information that opens up new prospects for the steady improvement of pre-professional education.

The New York City Cancer Committee has presented **Arthur Purdy Stout,** professor of pathology at Columbia University, with the Clement Cleveland Award for "outstanding work in the campaign to control cancer" in 1953.

M. J. Thirumalachar, mycologist who studied at the University of Wisconsin, has recently taken charge as chief mycologist at the Indian Government Penicillin Factory, Pimpri, Poona, India, after spending a year working with E. B. Chain at the Istituto Superiore Di Sanita in Rome, Italy. During his stay in Europe Dr. Thirumalachar visited laboratories in Italy, Germany, Switzerland, France, Holland, Denmark, and Norway.

Richard Trumball recently joined the staff of the Office of Naval Research in Washington as assistant head of the Physiological Psychology Branch. A former member of the faculty of Syracuse University, Dr. Trumball has just completed 2 yr of military service as a member of the staff of the U.S. Naval School of Aviation Medicine, Pensacola, Fla., and more recently, as assistant head of the Aviation Psychology Branch at the Bureau of Medicine and Surgery.

Peter A. van der Meulen, director of the Rutgers University School of Chemistry, has received the annual Honor Scroll of the New Jersey Chapter of the American Institute of Chemists.

John W. Wells of Cornell University will represent the National Academy of Sciences—National Research Council at the 2nd Congress of the Pan Indian Ocean Association that is to be held in Perth, Australia, Aug. 17–24. Dr. Wells is at present carrying out a research and teaching assignment with the Department of Geology of the University of Queensland, Brisbane.

Education

A 24,000,000-v **betatron** for the treatment and study of cancer and other biological and physical problems has been installed in the new Barnard Free Skin and Cancer Hospital by the Edward Mallinckrodt Institute of Radiology of the Washington University School of Medicine.

An **instructional television system,** built specifically for training purposes, was exhibited at the Armed Forces Communications Conference in Washington, D.C., May 6–7. It was developed by the Office of Naval Research at the Special Devices Center, Port Washington, N.Y. The simplified instruments were especially designed for use by ordinary classroom and laboratory instructors and eliminate the need for costly studio equipment and personnel that has made educational TV too expensive.

The prototype model displayed at the meeting had one Orthicon camera with provision for including two more. The camera, with its complete receiving and transmitting equipment and sound system, has been housed in a small, portable, desklike console. From this the TV program can be transmitted by cable to as many as 100 different receivers, located in as many different areas.

For technical skill training, it would be possible for each student to have a TV receiver at his work bench and follow the instructor's step-by-step process while watching TV close-ups. By using two cameras with the system, instructor and class can remain in the classroom while an assistant takes a camera to areas outside, thus saving valuable class time.

Specialists in the field of blood coagulation from medical centers throughout the United States and abroad participated in a 2-day conference on hemorrhage diseases May 21–22 at the **Marquette University School of Medicine.** The conference, held in conjunction with dedication of the new Eben J. and Helene M. Carey Memorial Library, $1,000,000 addition to the Medical School, was to honor Dr. Carey, late dean, and Armand J. Quick, professor and director of the Biochemistry Department.

Dr. Quick, during 20 yr of research in the field, has

brought world-wide attention to Marquette as a center for the study of blood coagulation. He received the American Medical Association's gold medal in 1944 and the Modern Medicine Award in 1954. Participants in the conference included Tage Astrup of Copenhagen and Alfredo Pavlovsky of Buenos Aires.

Pratt Institute will offer a program leading to the degree of **Master of Industrial Design** in the academic year 1954–55. Candidates must have a B.A. degree in design, architecture, or engineering and show promise in advanced design and product planning. A total of 32 semester hours is required for the degree.

The courses are also available to designers who may wish to do refresher work. Students will be expected to complete a number of projects based on objectives of the program. Major projects will include studies in design, structure, equipment, production operations, professional practices, and social and economic research. Field trips and special study in industrial designing and product planning are also included in the required work.

A recent issue of the *Journal of the American Dental Association* said editorially that federal **support of dental research** is far at variance with the nation's annual dental bill of more than a billion dollars. The *Journal* reported that only $229,607 in research grants had been allocated to the National Institute of Dental Research for the fiscal year ending next July, representing only 1.1 percent of the total U.S. Public Health Service grant budget of nearly $21 million for the year. For research fellowships, there were 11 awards in dentistry out of a total of 543 fellowships.

Most of the research work in the physical sciences being conducted at the **University of Arkansas** was integrated into the academic departments when the school's Institute of Science and Technology became a division of the College of Arts and Sciences on Jan. 1. The move was designed to make more effective use of both research personnel and research facilities.

Grants and Fellowships

The following **AAAS research grants** have been awarded:

California Academy of Sciences to L. E. Salanave. Photographic and photoelectric measurements of shadow bands.

Michigan Academy of Science, Arts, and Letters to Gertrude R. Kurath. Songs, dances and religious customs of modern Michigan Algonquians.

New Orleans Academy of Sciences to J. E. Tempesta, National University of Mexico. Purification of a glycoside with marked cardiac action.

South Carolina Academy of Science to J. R. Sampey, Furman University. Surveys of the literature in various medical fields.

Virginia Academy of Science to W. H. Lewis, University of Virginia. Cyto-taxonomic analysis of rosa species of Virginia and adjacent areas.

Virginia Academy of Science to K. W. King, Virginia Polytechnic Institute. Purchase of a monochromatic colorimeter.

The Air University of the U.S. Air Force announces its second series of research awards, beginning with the academic year 1954–55. Applications for two kinds of awards are invited:

1. **Air University Research Assistantships** are intended for graduate students in colleges and universities who have completed most or all of their course work for the doctorate and are ready to begin research on a doctoral dissertation problem. These 1-yr appointments carry with them compensation ranging from $3410 to $4205 per year.

2. Faculty members of civilian colleges and universities and staff members of research institutions may apply for 1-yr appointments as **Air University Research Associates.** Compensation ranges from $5060 to $7040.

The assistants and associates will have opportunities to work in the following fields: medical science, clinical medicine, military (aviation) medicine, maintenance engineering, sociology, anthropology, geology, geography, and botany. For detailed information concerning these awards, see the booklet, "Air University Awards," which may be obtained from the Commander, Air University, Maxwell Air Force Base, Ala.

The **American Dermatological Association** is again offering prizes for the best essays submitted for original work, not previously published, relative to some fundamental aspect of dermatology or syphilology. The purpose of this contest is to stimulate investigators to original work in these fields. Cash prizes will be awarded as follows: $500, $300, and $200 for 1st, 2nd, and 3rd place, respectively. Competition is not limited to physicians. The candidate winning first prize may be invited to present his paper before the annual meeting of the Association, with expenses paid in addition to the cash award.

The manuscript must be typed in English with double spacing and ample margins. Together with illustrations, charts, and tables, all of which must be in triplicate, it is to be submitted *not later than November 15* to Dr. J. Lamar Callaway, Secretary, American Dermatological Association, Duke Hospital, Durham, N.C.

Eight chemistry, engineering, and physics students have been awarded $1000 **Atlas Powder Company** senior-year college scholarships.

To encourage and assist promising young scientists, **Eastman Kodak Company** has offered 27 fellowships to a corresponding number of educational institutions for the year 1954–55. All for advanced study, 18 of the fellowships are in chemistry, 5 in chemical engineering, and 4 in physics. Each award provides $1400 and an allowance for tuition and fees. The fellowship also provides for a payment of $1000 to the institution to help support the cost of the research undertaken by the students.

The institution will select a student in the last year of study for his doctorate. The basis of selection is the student's demonstrated ability in his major field of study, a high degree of technical promise, and financial need. One purpose of the fellowship is to enable the

recipient to devote full time to a research project. As a provision of the award, Kodak will assist the recipient to attend one of the important scientific or professional meetings appropriate to the field of study.

The Lederle Laboratories Division of the American Cyanamid Company announces that it is making available to medical schools throughout the U.S. and Canada **"Lederle Medical Student Research Fellowships."** These fellowships, in amounts up to $600 per year for any one individual, are intended to relieve in part the financial burden of students who desire to devote their summer vacations to research in the basic (preclinical) medical sciences.

Applicants must have the consent of the faculty member under whose supervision their research is to be conducted. Selection of students to receive such awards will be made by the dean of the medical school, or by the regularly constituted committee of the faculty charged with such selections. By special permission of the dean or of the fellowship committee of the school, the student may carry on such research in another medical school provided that satisfactory arrangements are previously made with that school.

Trustees of the **National Society for Crippled Children and Adults** have voted to launch a research project into the cause of crippling diseases. The group, a federation of state, county, and municipal societies, has an annual $10,000,000 aid program. Previously, it spent virtually all of its funds in direct aid to the crippled.

During the first year, 0.5 percent of income of the national and state groups will be devoted to the research project, which will be directed by William T. Sanger, past president of the society and president of the Medical College of Virginia.

The American Chemical Society is now prepared to make grants for research in the petroleum field from the **Petroleum Research Fund** set up some years ago for administration by the Society. The grants will be made by the Society's board of directors to persons recommended by a newly appointed Petroleum Research Fund Advisory Board that is under the chairmanship of Cary R. Wagner of Utica, Ohio.

Requests for grants-in-aid should be in the form of a written proposal describing the work to be done, the qualifications of the investigator for such research, the facilities available, the extent to which teaching and training of students may be advanced by the study, and the amount of money desired. All proposals should be sent in triplicate to the Petroleum Research Fund Advisory Board, American Chemical Society, 1155 16 St., N.W., Washington 6, D.C. *The board will meet early in June to screen applications* received up to that time.

For purposes of these grants, the "petroleum field" is considered to include any area of fundamental research that, as stated in the trust agreement creating the fund, may lead to research directly connected with the petroleum field. Under the policy laid down by the board, the work must be done in a nonprofit institution, either in the United States or abroad, and all patents resulting from such work must be immediately dedicated to the public, royalty free.

The **Porter Fellowship of the American Physiological Society** for the year 1954–55 has been awarded to Alvin Brodish, a graduate student in the Department of Physiology of Yale Medical School. The Porter Fellowship is supported by the Harvard Instrument Company, which was founded by William T. Porter, late professor of physiology in Harvard Medical School. The fellowship is given every year to a student of physiology who shows great promise as a teacher and investigator.

The Italian Government, through the Cultural Relations Office of the Ministry of Foreign Affairs, offers **six fellowships** to American graduate students for study in Italy for a minimum period of 6 mo between October 1954 and July 1955. The Italian Embassy in Washington will pay $300 toward round-trip travel on an Italian ship or plane.

Men or women may apply in any field. Requirements include a master's degree or the equivalent in advanced work, such as recognition as an artist, scholar, or scientist. *Completed applications must be filed at the Institute by July 1.* For information write to the U.S. Student Department, Institute of International Education, 1 E. 67 St., New York 21.

Meetings and Elections

An alumni symposium in chemistry honoring **Roger Adams,** University of Illinois chemistry department head for 28 yr who is retiring Sept. 1, will be held in Urbana, Sept. 3–4. All who have been in the department under Prof. Adams' leadership—as undergraduates, graduate or postgraduate students, or staff members—are invited to the symposium, which is being organized by the organic chemistry group at the university at the request of Prof. Adams' 166 doctorate students.

Five former students, all members of the National Academy of Sciences, will present papers: Wendell M. Stanley, Nobel Prize winner and head of the University of California Virus Institute, Berkeley, "Chemistry of viruses"; John R. Johnson, head of organic chemistry, Cornell University, "Chemistry of gliotoxin"; Samuel M. McElvain, head of organic chemistry, University of Wisconsin, "Structure of nepatalic acid"; Ralph L. Shriner, acting chemistry department head, University of Iowa, "Chemistry of flavylium salts"; and Wallace R. Brode, associate director, National Bureau of Standards, "Steric factors and the color of organic molecules."

Ernest H. Volwiler, president, Abbott Laboratories, Chicago, who was Prof. Adams' first doctorate graduate at Illinois, will open the symposium and preside at the morning session; William E. Hanford, vice president in charge of research and development,

M. W. Kellogg Co., New York, will be in the chair for the afternoon session; and William H. Lycan, vice president in charge of research and development, Johnson and Johnson Co., New Brunswick, N.J., will officiate at the banquet. Arrangements have been made for publication of the papers presented. Reservations are being handled by Prof. Leonard E. Miller, Chemistry Department, University of Illinois.

Officers of the **American Eugenics Society** are: pres., C. Nash Herndon; v. pres., Harry L. Shapiro; sec., Frederick Osborn; treas. Chauncey Belknap.

On April 24 the **American Philosophical Society** elected the following officers for 1954–55: pres., Owen J. Roberts; v. presidents, George W. Corner, Alfred V. Kidder, and Oliver E. Buckley; secretaries, Richard H. Shryock and Henry Allen Moe; curator, Fiske Kimball; treas., Fidelity-Philadelphia Trust Company. Councilors, to serve for 3 yr, are: Donald H. Menzel, Mathematical and Physical Sciences; John S. Nicholas, Geological and Biological Sciences; Lewis W. Douglas, Social Sciences; and Lynn Thorndike, Humanities.

New members elected in the various mathematical, natural, and social sciences are: Crawford Hallock Greenewalt, Gaylord P. Harnwell, Charles C. Lauritsen, W. F. Libby, Kenneth S. Pitzer, E. M. Purcell, Manuel Sandoval Vallarta (Mexico), Ernst Cloos, Rene Dubos, Thomas Francis, Jr., David R. Goddard, Curt Stern, Ragnar Granit (Sweden), Solomon Fabricant, Grayson Kirk, Edward Sagendorph Mason, and Joseph J. Spengler.

The 49th annual meeting of the **American Urological Association** will be held in New York, May 31–June 3. There will be scientific and technical exhibits, motion pictures, and an essay competition, as well as technical reports by Association members. One of the features of the meeting will be the Guiteras Lecture, to be delivered this year by John Eager Howard. All physicians, including visitors from abroad, are invited to attend the scientific sessions.

Some 400 analytical chemists from all parts of country will convene at the University of Minnesota on June 18 for the 7th annual **Analytical Symposium of the American Chemical Society,** sponsored jointly by the Division of Analytical Chemistry and the Society's journal, *Analytical Chemistry.*

Methods of applying titration will be discussed at the symposium, which has as its topic "Recent developments in titrimetry." Philip J. Elving of the University of Michigan's department of chemistry is general chairman and I. M. Kolthoff, head of the analytical chemistry department at Minnesota, is honorary chairman. John E. Wertz of Minnesota is chairman of the committee on local arrangements.

The third postwar convention of the **British Institution of Radio Engineers** will be devoted exclusively to industrial electronics. The main theme is to show how electronics can increase qualitative and quantitative production, and production efficiency, in all branches of industry. The convention will be held at the University of Oxford, July 8–12.

Sir John Cockcroft, Director of Research, A.E.R.E., Harwell, will deliver the Institution's Clerk Maxwell Memorial Lecture. In addition, some 30 papers will be presented covering computers for industry and commerce, industrial x-ray equipment, the use of ultrasonics, nucleonic instrumentation, transducers in industrial production, and applications of electronics to process control. A program and reservation may be obtained from The Secretary, British Institution of Radio Engineers, 9 Bedford Square, London, W.C.1.

On Apr. 3, at San Francisco State College, the new **Far Western Section of the Association of Geology Teachers** was organized. This is the first section of the Association west of the Rockies. The following provisional officers were elected: pres., York T. Mandra, San Francisco State College; v. pres., Charles G. Higgins, University of California, Davis; sec.-treas., Robert M. Norris, Santa Barbara College.

The first regular business meeting of the section will be held at the national meeting of the Geological Society of America in Los Angeles in November. At that time, a regular slate of officers will be elected for 1955.

The **Federation of American Scientists** has announced the following officers for 1954–55: chairman, M. Stanley Livingston, professor of physics at Massachusetts Institute of Technology; v.-chairman, Ernest C. Pollard, professor of physics at Yale University and chairman of the Scientists' Committee on Loyalty and Security (FAS); sec., Lewi Tonks, research associate at the Knolls Atomic Power Laboratory, General Electric Company, Schenectady; treas., Arthur S. Wightman, professor of physics at Princeton University.

Other members of the Federation's newly elected Executive Committee are: William A. Higinbotham, Brookhaven National Laboratory; David L. Hill, Los Alamos Scientific Laboratory; and John S. Toll, University of Maryland.

A conference on the **Impact of Solid State Science on Engineering Materials** will be held at Carnegie Institute of Technology, June 21–25, under the joint sponsorship of the Institute, the American Society of Electrical Engineering, the National Science Foundation, and the University of Illinois. The objective is to bring to the attention of engineering educators the important recent contributions of solid state physics toward the understanding of properties of engineering materials and to encourage the incorporation of such learning into engineering curriculums.

Topics to be covered at the conference include, in addition to an introductory survey of the theory of the solid state, mechanical and thermal properties, adsorption, catalysis and corrosion, and finally, a physical basis of the properties of polymers, ceramics, plastics, and cements. Leading physicists and engineers

will discuss the basic theory and engineering applications associated with the respective phenemona, their understanding, and the possibility for future research and development.

Among those who will participate in the conference are: John Bardeen, University of Illinois; Harvey Brooks, Harvard University; K. Lark-Horovitz, Purdue University; T. A. Read, Columbia University; and J. E. Goldman, H. Jones, W. Leivo, H. Paxton, and R. Smoluchowski of Carnegie Institute of Technology. Engineering educators who wish to attend should write to John W. Graham, Jr., Assistant Dean, College of Engineering and Science, Carnegie Institute of Technology, Pittsburgh 13, Pa.

The **New Orleans Academy of Sciences** has elected the following officers for 1954: pres., John G. Arnold, Jr., Loyola University; v. pres., Willis Eggler, Sophie Newcomb Memorial College; sec., John H. Mullahy, Loyola University; treas., Philip Wakeley, Forest Experimental Station.

Officers of the **Society for Industrial Microbiology** for 1954 are: pres., James G. Horsfall, Connecticut Agricultural Experiment Station, New Haven; v. pres., H. B. Woodruff, Merck & Co., Rahway, N.J.; sec.-treas., C. L. Porter, Purdue University, Lafayette, Ind.; dir., C. W. Hesseltine, Northern Regional Research Laboratory, Peoria, Ill.

The annual **summer biological symposium** is to be held this year at the University of Michigan. All are invited to attend the meetings, which are to be on the subject of "Adaptations in microorganisms." The program follows:

July 12–16. Sol Spiegelman, University of Illinois: (1) "Transmission of enzyme synthesizing capacity;" (2) "Properties of the enzyme synthesizing mechanism." Joshua Lederberg, University of Wisconsin: (1) "Mechanisms of bacterial adaptation against chemotherapy"; (2) "Serological variations in Salmonella."

July 19–23. John R. Preer, Jr., University of Pennsylvania: (1) "Inheritance of adaptive responses in protozoa; (2) "Cytoplasmic factor, kappa, in paramecium." Francis J. Ryan, Columbia University: (1) "Randomness of mutation in bacteria;" (2) "Selective mechanisms in bacteria."

The program of the 13th annual **Symposium of the Society for the Study of Development and Growth** to be held at Dartmouth College, June 23–26, is as follows:

June 23. David R. Goddard, University of Pennsylvania, opening address; Roger Stanier, University of California, Berkeley, "Plasticity of enzymatic patterns in microbial cells"; Seymour Cohen, Children's Hospital, Philadelphia, "The transformation of bacterial metabolisms induced by virus infection"; Ralph Emerson, University of California, Berkeley, "The biology of water molds."

June 24. Dietrich Bodenstein, Army Chemical Center, Md., "Insect morphogenesis"; Clifford Grobstein, National Institutes of Health, "Tissue interaction in the morphogenesis of mouse embryonic rudiments in vitro"; E. S. Russell, Roscoe B. Jackson Memorial Laboratory, "Review of pleiotrophic effects of W-series genes on growth and differentiation."

June 25. Linus Pauling, California Institute of Technology, "Duplication of molecules"; Joseph S. Fruton, Yale University, "Biosynthesis of proteins and peptides"; James Ebert, Indiana University, "Aspects of protein biosynthesis in development."

June 26. Sterling Hendricks and Harry Borthwick, U.S. Department of Agriculture, Beltsville, Md., "Photoresponsive growth control"; Nelson T. Spratt, Jr., University of Minnesota, "Studies on the organizer center of the early chick embryo."

A **symposium on electrolytes** will be held by the American Chemical Society's Division of Physical and Inorganic Chemistry at Yale University, June 16–18. Peter J. W. Debye of Cornell University, Charles A. Kraus of Brown University, and John G. Kirkwood of Yale will be among the 31 speakers on the symposium program.

Miscellaneous

Signal and communications engineers, theater operators, radio and television technicians, manufacturers, and other persons engaged in work involving acoustical measurements now have available an **American Standard on Letter Symbols for Acoustics.** Published by The American Society of Mechanical Engineers under the procedures of American Standards Association, the new pamphlet lists more than 100 symbols. Copies may be obtained for $1.00 from the ASME, 29 W. 39 St., New York 18.

Preparation of the standard was begun in 1949 by a group under the chairmanship of Harry F. Olsen, RCA Laboratories, Princeton, N. J. The group operates under the Sectional Committee on Letter Symbols, chairman of which is H. J. Turner, associate professor of electrical engineering at Yale University. Established in 1926, the committee has now produced a total of 13 standards in letter symbols for mathematics, hydraulics, mechanics, structural analysis, heat and thermodynamics, illuminating engineering, aeronautical sciences, electrical quantities, radio, physics, chemical engineering, meteorology, and acoustics.

The following **chemicals** are wanted by the Registry of Rare Chemicals, Armour Research Foundation of Illinois Institute of Technology, 35 W. 33 St., Chicago 16: silicon disulfide; potassium monoxide; diethylphosphine; 3,4-dimethylpyridine; 9-decenoic acid; isobutylene oxide; 4-hydroxyphthalic acid; 3-methyl-2-naphthoic acid; 1-nitroheptane; 2,5-dimethyl-1,-4-dioxane; 2,5-dimethyl-1,5-hexadiene; 3-methoxy-3-ethyl-1,6-hexandiol; 2,6-diaminopimelic acid; esculetin; gentisic aldehyde; mycophenolic acid; lanosterol; elemicin; bromelin; creatininease.

The **Eye-Bank for Sight Restoration, Inc.**, 210 E. 64 St., New York 21, urgently needs eyes. The donation procedure instructions read: "Sign the release, have your signature witnessed, and give same to your next of kin, or to whoever will have charge of your burial arrangements. . . ."

Comprehensive listings of active **projects in food and nutrition research,** the laboratories, supporting organizations, and professional research personnel engaged in the research have been published as the results of surveys conducted by the Food and Nutrition Board of the National Research Council for 1947, 1948–49, and 1952–53. These publications list 4000 to 4800 projects, between 600 and 660 organizations conducting or supporting research, and the names of about 5000 professional research workers. Of the organizations listed, approximately 50 percent are industrial, 40 percent academic, and 10 percent governmental.

The research is classified by subject categories relating to physiology and biochemistry, food chemistry, food technology, microbiology, food acceptance, and nutrition education. Of the research projects recorded, approximately 40 percent pertained to nutrient metabolism and requirements (physiology), 30 percent to food chemistry and composition, 20 percent to food technology, and 10 percent to microbiology, food acceptance, and nutrition education. Between 1947 and 1953 there has been a possibly significant increase in the number of projects devoted to food technology and a decrease in the number devoted to food chemistry and composition.

The objective of the surveys has been to provide a published guide for research workers to use in finding promptly what research was done in a field of interest, where it was done and how financed, and who did it. The third survey was supported by contract with the U.S. Department of Agriculture, and the published volume will be available through the Government Printing Office.

The Scientific Monthly for June will feature these articles: "Geology and health," Harry V. Warren; "The Colorado Plateau Province as a field for Geological Survey study," Mary C. Rabbitt; "People, energy, and food," Warren Weaver; "Human relations and technical assistance in public health," E. Ross Jenney and Ozzie G. Simmons; "Science and social conservatism," Leonard Carmichael; "Blueprint for autobahn, U.S.A.," Paul F. Griffin.

Necrology

David Becker, 54, president of the American Academy of Dental Medicine, Montclair, N.J., May 6; **Gerald E. K. Branch,** 67, professor of chemistry at the University of California, Berkeley, Apr. 14; **Finn J. Bronner,** 66, author and professor emeritus of comparative anatomy, dental morphology and occlusion at New York University College of Dentistry, New York City, Apr. 12; **James E. Brooks,** 84, retired civil engineer and authority on mosquito control, Glen Ridge, N.J., Apr. 23; **Henry Bunting,** 43, associate professor of pathology at the Yale Medical School, New Haven, Conn., Apr. 15; **LeGrand H. Hardy,** 59, authority on the physiology of the eye, author, president of the American Orthoptic Council, and clinical professor of ophthalmology at the College of Physicians and Surgeons of Columbia University, New York City, Apr. 14; **Frederick D. Heald,** 81, author, former editor, and professor emeritus of plant pathology at Washington State College, Pullman, Apr. 24; **Wendell F. Hess,** 51, metallurgist, former president of the American Welding Society, and director of research at Rensselaer Polytechnic Institute, Troy, N.Y., Apr. 21; **Earnest A. Hooton,** 67, author and chairman of the Department of Anthropology at Harvard University, Cambridge, Mass., May 3; **Joseph S. Knapper,** 66, professor of chemistry and mathematics at Albright College, Reading, and Pennsylvania State University, State College, May 4; **Charles I. Lambert,** 76, medical director of Four Winds Hospital, Katonah, N.Y., former professor of psychiatric education at Teachers College, Columbia University, and former associate professor of psychiatry at Columbia's College of Physicians and Surgeons, New York City, Apr. 18.

Ellis L. Manning, 53, author and physicist for the Signal Corps Engineering Laboratories, Fort Monmouth, N.J., Mar. 27; **Harrison S. Martland, Sr.,** 70, research pathologist, author, pioneer in radioactive diseases, and retired professor of forensic medicine at New York University, New York City, May 1; **Herman O. Mosenthal,** 75, authority on diabetes, former president of the American Diabetes Association, and former director of the Department of Medicine at New York Post-Graduate Medical School, New York City, Apr. 24; **Chester N. Myers,** 69, research chemist and specialist in chemotherapy and skin diseases, Yonkers, N.Y., May 3; **Ira T. Nathanson,** 49, cancer specialist and associate clinical professor of surgery at Harvard Medical School, Boston, Mass., May 3; **James D. Pilcher,** 74, head of the Pediatrics Department at City Hospital, Cleveland, Ohio, May 4; **Swanie S. Rossander,** 50, author, inventor, and assistant director of the Jackson Laboratory, Wilmington, Del., Apr. 17; **Herman A. Shelanski,** 42, discoverer of blood plasma substitute and director of the Industrial Toxicology Laboratories, Philadelphia, Pa., Apr. 13; **J. J. Singer,** 71, specialist in chest diseases and associate professor of medicine at the University of Southern California, Los Angeles, Apr. 13; **Lewis J. Stadler,** 57, research geneticist, former president of the Genetics Society of America, and professor of field crops at the University of Missouri, St. Louis, May 12; **William O. Vanderburg,** 58, mining engineer and authority on mineral production and supply for the State Department, Washington, D.C., Apr. 16; **Jerald G. Wooley,** 64, former head of the clinical laboratory of the National Leprosarium and authority on animal nutrition requirements for the National Institutes of Health, Bethesda, Md., Apr. 20.

Book Reviews

The Effect of ACTH and Cortisone upon Infection and Resistance. Gregory Shwartzman, Ed. Columbia Univ. Press, New York, 1953. 204 pp. Illus. $5.50.

This monograph comprises 14 papers given by different authorities at a symposium sponsored by the New York Academy of Medicine, Mar. 27–28, 1952. Since this time many excellent reports of studies covering the same subjects by these and other authors have appeared. They contain, however, little new basic information beyond what is recorded in this volume. The emphasis is on factual detail and not on generalities. The authors, although admitting an incomplete discussion of their respective subjects, have adequately documented their presentations through detailed reference to their own studies as well as those of others, as indicated by the appended bibliographies.

Dr. Shwartzman gives a brief introductory review of shifting interests "in the sciences dealing with infection and resistance." Beginning with the "era of specificity" when host resistance was explained more or less entirely on the basis of development of specific antibody to a given agent, he calls attention to an increasing body of evidence which indicates that resistance includes many factors "unrelated to specific immunity." He comments particularly on the investigations that have led to the recognition of the role of hormones "in the predisposition and resistance to disease," especially in reference to adrenocortical function, the theme of this book.

In Chapters 2, 3, and 4, general considerations of the effect of hormones (particularly the corticosteroids) upon metabolic functions (enzymatic reactions) and structural elements (lymphoid tissue) of the host are presented as a means of more fully understanding the effect of these substances on infection and resistance. In the remaining chapters, data are presented which show the profound and usually depressing effect of ACTH and cortisone on hypersensitivity and allergic states, inherited and acquired resistance to tumor grafting, and antibody formation and wound healing. Also, data are presented that show the marked deleterious effect of these compounds on the host as a result of alteration in the inflammatory process in experimental tuberculosis, syphilis, malaria, trypanosomiasis, and bacterial (streptococcal and pneumococcal) and viral (influenza and poliomyelitis) infections. Among other effects, it is amply demonstrated that these compounds inhibit the inflammatory process and antibody formation but exert no effect on the invading organisms. Just how ACTH and cortisone do this of course still remains to be elucidated.

It is repeatedly pointed out, or implied, in this volume that although ACTH and cortisone provide new tools for the study of the host-parasite relationship in infectious processes, the "clinical use" of these hormones with patients suffering from infectious diseases, whatever the etiology, should be undertaken with caution. The data should be of special interest to the biochemists, microbiologists, immunologists, clinicians, and others who are interested in the role of ACTH, cortisone, and other hormones on the basic immune mechanisms in man and animals.

CLAYTON G. LOOSLI

Department of Medicine
The University of Chicago

A History of the Theories of Aether and Electricity: The Modern Theories, 1900–1926. Sir Edmund Whittaker. Philosophical Library, New York; Thomas Nelson, Edinburgh–London, 1954. 319 pp. $8.75.

The present volume is not, as the title would suggest, merely a 26-year extension of the work originally written by Sir Edmund Whittaker under the same title in 1910 (*1*). It is, rather, a thorough and authoritative chronicle of the development of theoretical physics in the period 1900–26, including atomic structure, special relativity, quantum theory, general relativity, matrix mechanics, and wave mechanics. In contrast to the original volume, it contains only one 15-page chapter on electromagnetic theory. In the words of the preface, the purpose is "to describe the revolution in physics which took place in the first quarter of the twentieth century." The author promises a third volume which will bring the account up through 1950.

For those who, like this reviewer, have paid scant attention to the sequence and authorship of the rapid advances made in the early part of this century, the book will contain several surprises. For example, because of his monumental development of general relativity, Einstein is often credited with originating special relativity as well. Actually, special relativity was due primarily to Poincaré (and, of course, Lorentz). It was Poincaré who, in a lecture at St. Louis, Mo., in 1904, first enunciated the "principle of relativity" and said that according to this principle, "the laws of physical phenomena must be the same for a fixed observer as for an observer who has a uniform motion of translation relative to him," and that as a consequence "there must arise an entirely new kind of dynamics, which will be characterized above all by the rule that no velocity can exceed the velocity of light." Ironically, it seems that in the development of special relativity, the theoretical physics was supplied by Poincaré, while the mathematics was contributed by the physicist Lorentz. Actually, among Einstein's early contributions, the most significant were probably to the quantum theory, a fact which was recognized by the Nobel prize committee in 1921. Again ironically, it was the father of the quantum

theory, Max Planck, who in 1906 first obtained the relativistic equations of motion.

Planck's development of his radiation formula is also an interesting story. His first derivation in 1900 was based purely on thermodynamical arguments, and he later introduced the quantum hypothesis to provide a sounder theoretical basis. But Planck was never happy with this hypothesis and spent many years in fruitless efforts to revise it so as to avoid its apparent conflict with Maxwell's electrodynamics. Ultimately, however, his "second" and "third" theories (1911 and 1914, respectively) were swept away by the quantistic avalanche he himself had started.

Probably the most important theme of the book is that the great and "radical" theories were often the fruitful acceptance of an earlier suggestion or, more commonly, a successful amalgamation of various aspects of currently competing theories. This in no way detracts from the genius of the great pioneers, but it gives the advance of science a more orderly and evolutionary character. Thus, for example, the spin of the electron had been suggested by A. H. Compton in 1921, 4 years before Goudsmit and Uhlenbeck's celebrated paper. Also, Bohr's atomic theory is described by Whittaker as being based on nine fundamental principles, the first eight due to Conway, Nicholson, Rutherford, Ritz, Planck, and others, and the ninth, the renunciation of any classical explanation of electronic transitions, the one new element that Bohr added to create a successful theory.

An apparent exception was Heisenberg's matrix mechanics, although even here there is some connection with Landé's theory of the "virtual orchestra." The book ends with two chapters on the parallel development of this theory and Schroedinger's wave mechanics, their astonishingly rapid early successes, the demonstration of their equivalence by Schroedinger and by Eckart, and their connection with classical theory and with the older Sommerfeld-Wilson quantum theory.

Let no one be deceived by the foregoing into thinking that this work is merely a chronological and anecdotal history, or that it is light reading suitable for the layman. As a matter of fact, it contains considerable critical analysis and as much mathematical development as many textbooks in theoretical physics (for example, a 10-page exposition of Ricci's tensor calculus), and it is copiously documented with references to original papers on both the successful and the unsuccessful theories. It is a book written for those with sufficient background in mathematical physics to appreciate the significance of the discoveries discussed, to understand the mathematical treatment of them, and to enjoy the broader perspective it will undoubtedly give. To such people it can be heartily recommended.

E. T. KORNHAUSER
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Reference

1. *A History of the Theories of Aether and Electricity, from the Age of Descartes to the Close of the Nineteenth Century*, Dublin Univ. Press, Longmans, Green, London, 1910. A revised and expanded edition, subtitled *The Classical Theories* and uniform with the present volume, was published in 1951 by Thomas Nelson.

New Books

Adaptation in Micro-organisms. Third Symposium of the Society for General Microbiology, Apr., 1953. E. F. Gale and R. Davies, Eds. Cambridge Univ. Press, New York, 1953. 339 pp. Illus. + plates. $6.

Expédition Océanographique Belge dans les Eaux Côtières Africaines de l'Atlantique Sud (1948–49): ***Résultats Scientifiques.*** Vol. IV, Fasc. 2: ***Poissons: Téléostéens Malacoptérygiens.*** Max Poll. 258 pp. Illus. + plates. Vol. IV, Fasc. 4: *Annélides Polychètes Non Pélagiques.* Pierre Fauvel. 56 pp. Illus. Institut Royal des Sciences Naturelles de Belgique, Brussels, 1953.

The Mind and the Eye. A study of the biologist's standpoint. Agnes Arber. Cambridge Univ. Press, New York, 1954. 146 pp. $3.

A First Course in Ordinary Differential Equations. Rudolph E. Langer. Wiley, New York; Chapman & Hall, London, 1954. 249 pp. Illus. $4.50.

Treatise on Invertebrate Paleontology. Raymond C. Moore, Ed. Pt. G: *Bryozoa.* Ray S. Bassler. Prepared under the guidance of the Joint Committee on Invertebrate Paleontology of the Paleontological Society, the Society of Economic Paleontologists and Mineralogists, and the Palaeontographical Society. Geological Society, New York; Lawrence, Univ. of Kansas Press, 1953. 253 pp. Illus. $3.

A Field Guide to Rocks and Minerals. Frederick H. Pough. Houghton Mifflin, Boston, 1953. 333 pp. Illus. + plates. $3.75.

Microwave Lenses. J. Brown. Methuen, London; Wiley, New York, 1953. 125 pp. Illus. + plates. $2.

Progress in Cosmic Ray Physics. Vol. II. J. G. Wilson, Ed. North-Holland, Amsterdam; Interscience, New York, 1954. 322 pp. Illus. $8.50.

Ancient History of Western Asia, India and Crete. Bedrich Hrozny. Trans. by Jindrich Prochazka. Philosophical Library, New York, 1953. 260 pp. Illus. + color plates + maps. $12.

Analysis of Deformation. Vol. I. Keith Swainger. Chapman & Hall, London, 1954. 285 pp. Illus. 63s.

Biological Conservation. With particular emphasis on wildlife. John D. Black. Blakiston, New York, 1954. 328 pp. Illus. $5.00.

Methods of Theoretical Physics, Parts I & II. Philip M. Morse and Herman Feshbach. McGraw-Hill, New York–London, 1953. 1978 pp. Illus. $30.00 the set, $15.00 a volume.

Geography in the Twentieth Century. Griffith Taylor, Ed. Philosophical Library, New York; Methuen, London, 1953. 661 pp. Illus. + plates + maps. $8.75.

Laboratory Practice of Organic Chemistry. 3rd ed. G. Ross Robertson. Macmillan, New York, 1954. 377 pp. Illus. $4.00.

Flow Properties of Disperse Systems. Vol. V of *Deformation and Flow.* J. J. Hermans, Ed. North Holland Pub., Amsterdam; Interscience, New York, 1953. 445 pp. Illus. + plates. $9.90.

Dairy Cattle Feeding and Management. 4th ed. H. O. Henderson and Paul M. Reaves. Wiley, New York; Chapman & Hall, London, 1954. 614 pp. Illus. $6.50.

Technical Papers

Preparation of the Inorganic Matrix of Bone*

J. B. Williams and J. W. Irvine, Jr.

Radioactivity Center and Department of Chemistry, Laboratory for Nuclear Science, Massachusetts Institute of Technology, Cambridge

For many purposes in biology and medicine, it is desirable to obtain intact the inorganic salt fraction of bone separated from its organic environment. The methods in common use at present are glycol-ashing at temperatures greater than 200°C (*1–3*), dry-ashing in a muffle furnace at temperatures in excess of 500°C, and high-temperature autoclaving (*4*).

Glycol-ashing, or boiling in a KOH-glycol solution, alters the cation and anion makeup and can leave collagen in bone (*5*). Treatment at elevated temperatures can cause serious alteration in the crystal structure as well as in the gross structural pattern (*6*).

Among the requirements of an extraction solvent are that it must attack vigorously the organic matrix of bone at as low temperature as possible and volatilize easily, so that it can be readily distilled from possible nonvolatile contaminants. Extraction must be achieved with a minimum of erosion and dislocation of gross inorganic particulates.

These conditions have been met by the use of a constant-boiling (118°C) aqueous (80 percent) mixture of ethylene diamine in a soxhlet extractor. A filter paper thimble is used for the extraction of small or fragmented samples. The process is carried out either by placing the bone in the liquid distillate or by suspending it in the vapor. Whole bones are split to expose their marrow cavities to the hot extractant during the 20 to 30 distillation cycles required.

Soxhlet extractors of any size and geometry may be used, with the qualification that large extraction chambers may require insulation or external heating to maintain the solvent at near-boiling temperatures. Large flat sections of bone have been extracted in a specially constructed large-area soxhlet. To minimize erosion and agitation, the tip of the water-cooled condenser has been bent to deliver the extractant along the side of the chamber. All glass equipment with ground glass joints (used without lubricants) makes the most satisfactory system. Cork, rubber, stopcock grease, and some metals are attacked by the solvent.

One hundred cubic centimeters of ethylene diamine is usually sufficient to extract a 5- to 10-g fresh bone sample. However, a replacement of the diamine may be required when the amount of organic material removed is large, since this dilution can cause a much larger decrease in the vapor concentration of the ethylene diamine. Because of the extreme solubility of ethylene diamine in water, several extraction cycles with distilled water are sufficient to remove essentially all the solvent. Because of the slight toxicity of ethylene diamine, the process is usually carried out in a hood.

* Supported in part by the joint program of the Office of Naval Research and the Atomic Energy Commission.

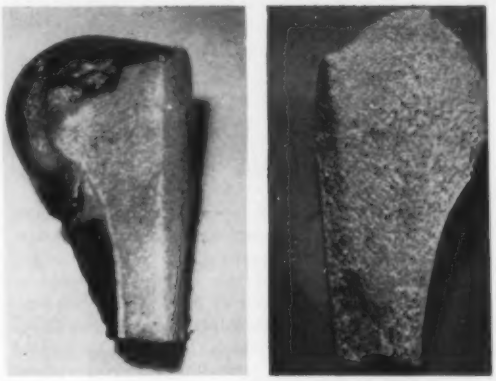

Fig. 1. (Left) Adjacent longitudinal sections of the distal epiphysis of a human femur, fresh. (Right) The same after extraction with ethylene diamine.

Comparative chemical analyses (*7*) of adjacent bones, one prepared by extraction, the other by ashing at 550°C, are tabulated as follows:

	Extracted (%)	*Dry-ashed* (%)
Calcium (Ca)	38.1	39.4
Phosphate (PO_4)	49.8	51.6
Carbonate (CO_3)	5.6	3.1

Preliminary differential thermal analyses (*8*) of extracted bone show a large exothermic reaction at

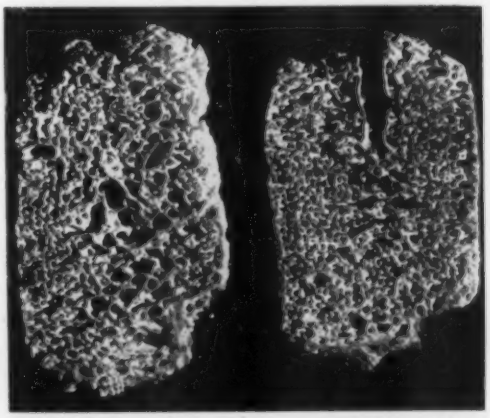

Fig. 2. Cross sections of two of a child's vertebrae after extraction.

580°C, indicating a possible recrystallization. For this reason, the dry-ashing procedure was carried out at 550°C. However, an apparent partial decomposition of the carbonate may still be noted from the tabulated results.

A preliminary x-ray diffraction powder pattern of this low-temperature extracted bone gives qualitatively the same spacing as bone prepared by other methods. (*9*) Electron-microscope studies of ground extracted bone show no trace of collagen confirming a nitrogen analysis (Kjeldahl) finding of less than 0.1 percent

Bone samples have been prepared by this technique (Figs. 1 and 2) for autoradiography, for demonstration of trabecular stress patterns, for radium analysis of normal bone, and for the separate analyses of tracers in the two fractions of bone. Extracted bone and bone powder have been implanted in dogs and are disposed of in a manner metabolically similar to that of fresh bone and other crystalline material without apparent organic reaction.

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Received March 12, 1954.

Trace Element Content of Cancerous and Noncancerous Human Liver Tissue*

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In a previous publication, a method (*1*) has been described for the quantitative study of 14 trace elements in biological material by spectrochemical means. In experimental rat hepatomas induced by p-dimethylaminoazobenzene (DAB), it has been shown (*2*) that zinc decreased in concentration during the period of liver damage and then increased with regeneration and appeared to be at its peak before gross neoplasia was evident. It seemed of interest to study trace elements in human tissue and the following is a preliminary report on the study of 12 trace elements in the livers of six patients without tumor, two patients dead of carcinoma of the esophagus and with hepatic cirrhosis but without tumor involvement of the liver, four cases with metastasis to the liver from cancer of the gastrointestinal tract, and one case of acute lymphatic leukemia (*3*). Table 1 lists the cases studied. In the six cases without cancer, histological examination of the livers revealed varying degrees of congestion.

Table 1. Cause of death.

Case No.	Diagnosis	Age
1	Generalized arteriosclerosis; bronchopneumonia	82
2	Myocardial infarction	68
3	Esophagitis and hemorrhage from esophageal varices	76
4	Chronic pyelonephritis	81
8	Cerebral artery thrombosis	80
10	Intestinal obstruction	54
23	Carcinoma of esophagus; portal cirrhosis	59
13	Carcinoma of esophagus; portal cirrhosis	62
17	Carcinoma of rectum*	69
18	Adenocarcinoma of colon*	67
14	Adenocarcinoma of colon*	41
6	Adenocarcinoma of stomach*	39
7	Acute lymphatic leukemia†	9

* Tumor metastasis to liver.
† Hepatic involvement.

Table 2 lists the analyses for zinc and indicates that this element is significantly elevated in the uninvolved portions of livers with metastatic carcinoma. Zinc is increased by 112 percent in the noncancerous portion of the livers with tumor as compared with nontumorous livers. In two patients with carcinoma of the esophagus and with cirrhosis of the liver without metastasis, the zinc concentration was essentially the same as in the noncancerous livers. In these last two cases, the copper concentration was strikingly elevated (165 percent). Zinc has been determined by the method used with an accuracy of ±3.27 percent and copper with an accuracy of ±9.02 percent; thus, it would seem that these findings are of significance. In one specimen, it was difficult to separate all the tumor tissue from liver tissue, and this sample had the lowest concentration of zinc (53.0 ppm), suggesting that considerable tumor tissue was analyzed.

Molybdenum was increased by 37 percent in the liver tissue of patients dying with metastasis to the liver, which is of questionable significance. Manganese, chromium, and tin were present in measurable amounts, but no significant difference was noted in cancerous and noncancerous livers. Nickel, aluminum, silver, lead, and cobalt were present in a few samples, but in most they were below the level of detection for the method of analysis used. Perhaps if larger samples are analyzed or with increased sensitivity of the method, further studies may reveal significant changes in these elements.

In all the tumor tissue studied, the trace elements were markedly decreased as compared with either the liver tissue to which metastasis had occurred or with

* These studies are supported in part by U.S. Public Health Service grant No. C-1121 to the Albany Medical College.

Table 2. Zinc content of human livers (parts per million of wet sample).

Non-cancerous liver	Portal cirrhosis†	Metastatic carcinoma*		
		Uninvolved liver	Tumor tissue	Lymphatic leukemia‡
36	33	98	26	135
26	41	68	16	
43		101	14	
34		53	18	
48				
39				
Avg. 37.7	37.0	80	18	

* Cases No. 17, 18, 14, 6.
† Carcinoma of the esophagus without hepatic involvement; cases No. 23 and 13.
‡ With hepatic infiltration.

noncancerous liver tissue. This is in agreement with other trace-element studies of tumor tissue.

In one case of acute lymphatic leukemia with hepatic infiltration, the liver revealed a marked increase of iron (301 percent), zinc (258 percent), and chromium (233 percent), and cobalt was present in a concentration of 0.96 ppm, whereas the highest concentration in any of the other livers was 0.05 ppm, and cobalt was not detected in most samples. Molybdenum and manganese were reduced, and tin was moderately increased. Lead and silver were present in measurable amounts, but it is not possible to say whether they are significantly increased, since they were found erratically in other livers. Nickel and aluminum were not detected.

Trace elements are probably linked to protein molecules in most instances and are frequently necessary for the activity of enzymes or enzyme systems. Zinc has been shown to be a component of carbonic anhydrase, possibly of uricase, carnosinase, and perhaps some peptidases. Copper is present in tyrosinase. Molybdenum is believed to be a component of xanthine oxidase (*4*). Many other such linkages exist. An attempt will be made to determine whether a trace-element "profile" or pattern exists for host and cancer tissue. It is yet to be determined whether these elements exist in a combined or ionic state. It is also possible that trace-element levels in blood plasma may give a clue to the levels of these elements in the viscera.

To summarize, 12 trace elements have been studied by a spectrographic method in the livers of six persons dying of noncancerous disease, two persons dying of carcinoma of the esophagus and portal cirrhosis of the liver, four persons dying of gastrointestinal cancer with metastasis to the liver, and one case of acute lymphatic leukemia. A significant increase in zinc occurred in the uninvolved portion of the liver in all cases with metastatic malignancy. Copper was elevated in the liver in two cases with portal cirrhosis and no cancer in the liver, although death was due to cancer of the esophagus. Iron, zinc, chromium, and cobalt were significantly elevated in the liver in one case of acute lymphatic leukemia with hepatic involvement.

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Received March 19, 1954.

Heat Death Temperatures and Exposure Times of *Goniobasis livescens*

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There are few useful records of heat death temperatures, because many authors neglected the time factor and the older experimenters paid little attention to individual variation. In a study of the heat death of an organism, the proportion of individuals dying out of those exposed should be determined at each of a series of exposure times and temperatures. In addition to the paucity of satisfactory measurements of heat death temperatures and exposure times, the effect of the rate of heating on these characteristics has been generally overlooked.

Dallinger (*1*) and Jollos (*2*) were able to raise the heat death temperature of protozoans by a process of gradual heating, but the heat acclimatization may have been genetical, resulting from selection, since the experiments extended over considerable periods of time. Huntsman and Sparks (*3*) determined the heat death temperatures of marine animals in which the temperature was raised 1°C every 5 min, but did not rapidly heat any individuals for comparison.

The following experiment was conducted to determine the relationship between temperature and exposure time in the production of heat death, and to determine whether there is a differential in the effects of slow and rapid heating on these factors. Individuals of *Goniobasis livescens* were exposed to temperatures up to 41°C for various periods. The snails ranged in weight from 0.3 to 1.1 g, with an average weight of approximately 0.5 g. They were collected in western Lake Erie during the summer and were subjected to experimental heating within a few hours after their collection, at which time the water in their containers had reached a room temperature of 21° to 28°C.

The temperatures of some of the snails were rapidly raised by submerging them in preheated lake water, whereas the temperatures of the others were slowly

Table 1. Mortality rate of *Goniobasis livescens* to heat exposure per 10 individuals.

Temp (°C)	1 min		5 min		10 min		20 min		30 min		60 min		120 min		180 min		240 min	
	S*	R	S	R	S	R	S	R	S	R	S	R	S	R	S	R	S	R
41	10																	
40		0		3		5												
39	8	0	9	3	10	4	10		10									
38	8	1	10	1	9	2	10	9	9	9		9						
37	3		5		5	2	6	2	8	7								
36	1	1	2		2	0	1	0	4	4	8	5						
35	1		0		1		0	0	0	1	1	2	2	0				
34	1		1		1		1	0	1	0	1	0	1	1	1	2	0	2
33	1		1				0	0	0	0								
32	1		1		0		1		0	0	0	0						
31	0				0													
30	0				0													
29	0																	

* S represents the slowly heated snails; R represents rapidly heated snails.

raised by increasing the temperature of the water 1°C every 5 min. Both groups were exposed to the ultimate temperature for periods ranging from 1 min to 4 hr. At the end of the exposure period, they were immediately transferred to lake water at room temperature, and individuals that were alive after 3 days were considered to have withstood heat death. Ten snails were tested under each set of conditions, and the numbers that died are shown in Table 1.

The minimum heat death temperature for the majority of individuals is indicated to be approximately 36°C. since most of the snails were killed by 1-hr exposure at this temperature, whereas only a minority were killed by 1-hr exposure at 35°C. The mortality increased with longer exposure at 36°C but not with longer exposure up to 2 hr at 35°C (Table 1). While there was great individual variation, the heat death temperatures for 50 percent of the rapidly heated snails exceeded 40° at 5 min, 40° at 10 min, between 37° and 38° at 20 min, between 36° and 37° at 30 min, and 36° at 60 min. The heat death temperatures for 50 percent of the slowly heated snails were between 37° and 38° at 1 min, 37° at 5 and 10 min, between 36° and 37° at 20 and 30 min, and between 35° and 36° at 60 and 120 min.

The heat death exposure times for 50 percent of the rapidly heated snails were 10 min at 40°, between 10 and 20 min at 39° and 38°, between 20 and 30 min at 37°, and 60 min at 36°. The heat death exposure times for 50 percent of the slowly heated snails were less than 1 min at 38°, 5 to 10 min at 37°, and between 30 and 60 min at 36°. These results indicate that the heat death exposure time decreased with increase of temperature above 36°C and that the heat death temperature decreased with increase of exposure time up to 60 min.

The results indicate that there is a differential in the effects of slow and rapid heating on the heat death temperatures and exposure times, although the differential was the reverse of that expected. Instead of the heat death temperatures and exposure times being greater for the gradually heated snails than for the rapidly heated snails, they were less. We believe that this results from the longer total exposure time to high temperatures of the slowly heated snails. It is evident that a temperature increase of 1°C every 5 min is not sufficiently slow to permit heat acclimatization of *Goniobasis livescens*. At this rate of heating, the temperature is raised before acclimatization to the preceding temperature increment is achieved. The fact that the heat death temperatures and exposure times are effected by the rate of heating indicates that, in a comparison of these characteristics of different organisms, the rates of heating should be given.

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Received February 19, 1954.

Aromatic Biosynthesis. XI. The Aromatization Step in the Synthesis of Phenylalanine*

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A wide variety of benzenoid compounds are produced from nonaromatic materials in the plant and microbial kingdoms. In none of these biosyntheses,

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however, has the actual aromatization reaction been accessible to experimental study; for though hydroaromatic precursors of certain aromatic metabolites have been recognized [shikimic acid and related compounds (*1*); *meso*-inositol (*2*)], these precursors are clearly several steps removed from aromaticity.

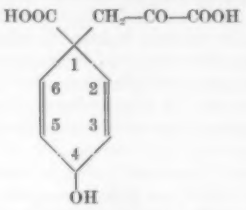
We now wish to report the isolation of a non-aromatic biosynthetic intermediate, prephenic acid (PPA) (*3, 4*), that appears to be the immediate precursor of an aromatic one. PPA is excreted by phenylalanine-requiring mutants of *Escherichia coli* (for example, strain 83–5) (*4, 5*). Exposure to even very mild acidity (for example, *p*H 6) converts it into phenylpyruvic acid (*4*); and we have now observed that this conversion can also be effected enzymatically by extracts of wild-type *E. coli* but not by comparable extracts of strain 83–5, which is blocked between PPA and phenylpyruvic acid. PPA is nutritionally inactive, but the foregoing enzymatic observations imply that this inactivity is due to an accessibility barrier and, hence, offers no obstacle to considering this compound a true intermediate.

PPA was isolated in crystalline form from culture filtrates of mutant 83–5 by charcoal chromatography, precipitation as the barium salt from aqueous solution with methanol, and repeated precipitation from water with methanol or pyridine. The progress of purification was followed by acid-catalyzed conversion to phenylpyruvic acid, which was assayed spectrophotometrically in alkaline medium at 320 mμ. The apparent molecular weights, based on the assays, dropped on recrystallization from about 750 to constant values of 396–410. Elementary analysis is compatible with the formula $C_{10}H_{10}O_7Ba$ [found (*6*): C 31.66, H 2.82, Ba 36.02 percent; calculated: C 31.64, H 2.66, Ba 36.19 percent; mol. wt. 379.5]. The acid-catalyzed conversion of PPA to phenylpyruvic acid ($C_9H_8O_3$), which takes place in the absence of any ready electron acceptor (including oxygen), is accompanied by release of one equivalent of CO_2. It would follow that PPA is a C-10 dicarboxylic acid.

An aromatic structure is excluded for PPA on several grounds. On catalytic hydrogenation over platinum, the compound took up between three and four molar equivalents of hydrogen, whereas phenylpyruvic acid took up the expected one molar equivalent. The infra-red spectrum shows no trace of the band at wavelength 6.74 μ (wave number, 1485 cm^{-1}) that is present, and with identical shapes (*7*) in the spectra of cinnamic, β-phenylpropionic, and phenylpyruvic acids. Finally, although PPA shows strong end-absorption in the ultraviolet, reduction of its carbonyl group with $NaBH_4$ decreased this absorption to a level ($\varepsilon_{260} = 20$) incompatible with aromaticity or the presence of a conjugated double-bond system in the ring; and the reduced compound takes up two molar equivalents of Br_2.

The product of $NaBH_4$ treatment was also decarboxylated and aromatized by acid, yielding a substance provisionally identified as phenyllactic acid. This observation excludes the possibility that the decarboxylation depends on the presence of a β-keto acid grouping.

The following structure is proposed for PPA:



This structure is compatible with the aforementioned facts and is supported by the following further observations. (i) No optical activity could be detected. (ii) The product of catalytic hydrogenation lactonizes in acid solution, as is shown by treatment with hydroxylamine followed by $FeCl_3$. (iii) The presence of a hydroxyl group, plus a molecule of water of crystallization in the Ba^{++} salt (as required by its empirical formula), is supported by the demonstration that 3 hydrogen atoms exchange rapidly with D_2O (*8*). (iv) Degradation of shikimic acid and tyrosine, obtained from organisms grown on C^{14}-labeled glucose, has shown that the carboxyl of the former compound and the side-chain of the latter occupy the same site on the ring (*9, 10*).

The structure proposed can account for the ease of aromatization and decarboxylation under the influence of acid. This reaction is presumably initiated by proton attack on the ring hydroxyl group. PPA has a half-life, in aqueous solution at room temperature, of 130 hr at *p*H 7.0, 13 hr at 6.0, and 1.0 min in 1*N* HCl.

Further details of this work are to be published.

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Received April 26, 1954.

Communications

Blood Groups in Racial Classification

N. Lahovary [*Science* **117**, 259 (1953)] has attempted a reply to certain criticisms of mine and has presented again his methods of interpreting the blood-group data for various human populations. A. E. Mourant deals with some of Lahovary's arguments in a communication published herewith. I wish to discuss the point of the independence of genes, which Lahovary particularly raises in connection with my criticism.

I stated that Lahovary failed to realize that the characters by which we define races are independent of one another. He says that this is sound common knowledge, and that if he had been guilty of such an offense, he would heap ashes on his head "and wail in the Desert of Ignorance." However, it still seems to me that he did commit this error, and what is more, commits it once again in the very article he has written in his defense. In this article, he says

> Among Negroes of pure blood . . . *all* the features will be characteristic of the black race, notwithstanding the independence of the genes responsible for each character. A specific physical pattern will entail, therefore, just as specific a blood pattern, notwithstanding the theoretical independence of the genes, not only for each blood system, but for each blood group of each system. There is a general specificity working for the unity of each organism and of each racial entity . . . we cannot deny the existence of *parallel trends* making for harmony.

It seems to me that Lahovary, while playing lip service to the independence of the genes, is here trying to maintain that everything about a member of one race is different from the corresponding feature of a different race. This represents a point of view once defended by certain physical anthropologists but now abandoned. According to this obsolete view, it should be possible to identify a skeleton as that of a Negro merely by the examination of any one of the bones. Lahovary, if I understand him, thinks this ought to be possible merely by the determination of the place in any one of the nine blood-group systems into which the individual falls. It does not require much knowledge of serology or genetics to realize that this is sheer mysticism.

It is true that the characteristics of any individual must form a more or less harmonious whole, else he could not have survived fetal life, childhood, and manhood (or womanhood), but this does not mean that the various blood-group characteristics may not be found in individuals of practically any race. It would seem that the various blood-group genes are sufficiently compatible with the other genes that control racial differences (and with one another) to be able to form practically all possible combinations with them. What is characteristic of a race is a certain "constellation of characters" [W. C. Boyd, *Genetics and the Races of Man* (Little, Brown, Boston, 1950)] which has probably been produced by the action of agencies such as mutation, selection, and genetic drift. But there is no ABO or Rh gene, for example, that is found solely in the Negroes. The Rh^0 (cDe) gene, which, by its very high frequencies, serves to characterize Negro *populations,* is found also in many other races, although at much lower frequencies.

Lahovary postulated that the A and B in different populations would prove to be of "different intensity," and in his article in *Science* makes it clear that he was thinking of the subgroups, such as the division of A into A_1 and A_2. It is true that in some cases this does distinguish populations which would seem (judged solely by their ABO frequencies) to be similar, but this is not always true. The Australian aborigines and the Eskimos have remarkably similar ABO groups, having no B and about the same amount of A, and this A is in both cases A_1 exclusively. Some American Indians of North America also have similar frequencies. The amount of group B is similar in various Africans and Asiatics. Subgroups of B have not been convincingly demonstrated in the majority of populations studied. Therefore, it is still merely a hypothesis that the B in populations having similar B frequencies is "of different intensity."

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Received July 3, 1953.

N. Lahovary [*Science* **117**, 259 (1953)] has recently set out the methods and summarized the results of his application of blood-group investigations to the problem of human classification. He has at the same time replied to a criticism by W. C. Boyd and has stressed certain points in which his methods differ from those of Boyd and other workers. In view of the growing importance of this field of research, it is desirable that where different workers use fundamentally different methods, the implications of these should be generally known.

Lahovary has done almost as much as any other worker to apply the published data of blood grouping to the solution of anthropological problems; and most blood-group workers would agree with many of his conclusions. He, however, applies directly to anthropology the crude phenotypic classifications of the serologist and only very rarely and incidentally makes use of the accepted methods of genetical research. He thus places blood-group phenotypes in almost the same category as skin-color or head-form phenotypes. To most workers in the field, on the other hand, the very great and almost unique value of the blood groups in anthropology lies in the fact that their inheritance has been completely worked out in terms of Mendelian genetics, and that the established methods of genetical research are thus directly applicable to the solution of anthropological problems.

As one justification of his use of phenotype frequencies, Lahovary speaks of "the AB group conforming to expectation in the whites and, to a more limited extent, in the blacks, whereas it is much higher than the expected values in the Mongoloids and in the populations with a Mongoloid or Eurasiatic admixture." He states that "in the white fringe, a higher frequency of AB than the expected value is a diagnostic indication of Asiatic admixture" and (without giving any reference) that "Myslaveč assumes that this racial trait is probably due to a slightly different position of the respective genes in the yellow races, favoring certain linkages." I have found no evidence of this supposed excess of AB; moreover, of the five sets of observations on "Eurasiatics and Mongoloids" quoted in Table 1 of Lahovary's paper, four show a deficiency of AB, the fourth set being 100 percent group O. If, however, any bodies of data should show such a significant and consistent excess, the first thought of any serologist would be a suspicion of technical errors. If such errors could be eliminated from consideration, various genetical possibilities would have to be considered and explored, and until the purely genetical problem had been solved it would be necessary to refrain from drawing any anthropological conclusions from the material.

A corollary of Lahovary's attitude to phenotypes in isolation from the underlying genetical situation is his use of the "index of deviation" and the incorporation of such indices in a special type of deviation diagram. The index of deviation, though apparently a simple mathematical quantity, has no clear statistical meaning, and it incorporates and confuses the true differences between populations together with the sampling errors for each of them (as well as technical errors in the testing of them).

It is desirable, for certain purposes, to have a quantitative expression of the difference between two populations. As far as the ABO groups are concerned, this is very simply given in both direction and magnitude by the line on a Streng triangular diagram, which joins the two points representing the populations concerned. A single Streng diagram can thus incorporate with a high degree of statistical efficiency the information that is much less efficiently expressed by a number of Lahovary diagrams one less in number than the total number of points on the Streng diagram.

Where the number of independent variables concerned is greater than two, the mathematical expression of differences between populations poses a highly complex problem that is not solved by Lahovary's device of summing indiscriminately the differences in percentage frequencies of all phenotypes.

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Received July 15, 1953.

Rejoinders to W. C. Boyd and A. E. Mourant

In answer to my reply in *Science* to certain criticisms of my work by W. C. Boyd, who alleges that I do not give due recognition to the independence of the genes, Boyd maintains that I still commit this error. However, our points of view are not as far apart as Boyd seems to believe. The difference is not fundamental but lies more in stressing what *distinguishes* the various races or what they share *in common*.

The reader may judge for himself. I wrote: "There is a general specificity working for the unity of each organism and of each racial entity . . . we cannot deny [that is, notwithstanding the theoretical independence of the genes] the existence of *parallel trends* making for harmony." What does Boyd answer? "It is true that the characteristics of any individual must form a more or less harmonious whole. . . . What is characteristic of a race is a 'certain constellation of characters'." It does not appear to me that the difference between "parallel trends making for harmony" and a "constellation of characters forming a more or less harmonious whole" is very easy to perceive.

It might even be contended that, on the whole, "parallel trends" leave more to the independence of the genes than a "constellation of characters," a constellation implying, in the cosmos, a permanent and, judged by human measures, an irrevocable relationship. In slightly different terms, we therefore express a nearly similar opinion. Boyd's assertion that I am "paying lip service to the independence of the genes" is consequently somewhat gratuitous. What is unfortunately still more gratuitous is his saddling me with the strange theory that each individual has only his own racial genes, that, for instance, I presume that the ABO or Rh genes of the Negro or *everything* about a member of one race is different from the corresponding feature in a member of another race. This accusation is all the more surprising since my definition of "parallel trends," previously mentioned by Boyd, excludes such an interpretation. Moreover, this would also imply that I deny the existence of a human species, for it is clear that if every race had *only* its specific genes, there would be not *one* human species subdivided into various races but *several* different species of "humans." Needless to say, I never have harbored, nor could be supposed to harbor, so wildly revolutionary an idea.

The real difference between Boyd's conceptions and mine lies in the difference in emphasis. Whereas he stresses the *similarities* among the races and thus, indirectly, the independence of the genes, I stress their *distinctiveness* and, thereby, the racial correlations of the genes, because, as stated by F. v. Eickstedt, the great German anthropologist: "All characters are not inherited independently; on the contrary, most of them [I would say personally, at any rate many of them] are transmitted in correlated groups. . . . There could be otherwise no racial types, nor even any definite types at all." [*Rassenkunde und Rassengeschichte*

der Menschheit (Stuttgart, 1942), p. 592]. Without the transmission of the genes in more or less correlated groups, there would be no zoology or anthropology, as we know them, for no classification would ever have been possible.

If I stress racial specificity and thus, implicitly, the existence of correlated systems of genes, it is because I think it is also a more constructive approach to racial problems and more conducive to further progress than the opposite tendency. If we lay the stress on the characters (ergo, genes) that are inherited in common (that is, independently) by the greyhound, the bulldog, the pekinese, or the pointer, and so forth, and make them all belong to the canine species, this will not bring us very far in the study of the various races of dogs. What will be, on the contrary, much more fruitful will be to study the *distinctive* characters that make these various breeds differ.

The parallel trends or constellations of characters proving the very frequent correlations of genes, which find their expression in racial specificity, are evident in all the biologic potentialities of mankind, and the works devoted to their study are legion. I mention as a small sample, for the specificity of the skeleton (*1–5*), for the racial specificity of the brain, that is, correlation of the genes governing the development of the brain (*6–11*),. for the racial specificity and correlation of genes in the functions of the brain (*12–19*), for the racial specificity, or constellation of characters directing the chemical constitution of the blood, blood pressure, and heart, basal metabolism and temperature regulation (*20–28*), for racial specificity, that is, correlated transmission of genes concerning organic functions and morbidity (*29–37*), for various other genetic and racial correlations (*38–41*), and standard works, among many, giving numerous instances of racial correlations (*42–44*).

H. Vallois has stated his position in unequivocal terms: "The differences between the various races are much greater than was generally admitted . . . they effect the composition of our very tissues, all their intimate functions, for they affect indeed the whole being." ["La découverte des races," Sem. des Hôpitaux, Mar. 1952]

Racially correlated characters are thus found in the whole field of human biology, and even in psychology. This implies necessarily the existence of racial genic trends working in correlated harmony, the independent genes completing the picture by insuring the unity of the species. (The independent and the correlated genes evidently do not form two distinct classes but are transmitted independently, or in correlated groups, according to circumstances.) In this way, the independence and the interdependence of the genes are two complementary and necessary conditions of life as we know it.

With regard to the similarity observed by Boyd in the ABO frequencies of Eskimos and Australian aborigines, this detracts nothing from the specificity of each group, considering that in the other blood systems they are completely different. I agree, however, that no definite conclusion can be reached at present regarding the B subgroups.

A. E. Mourant's contribution to genetics and serology has been so considerable that any observation of his deserves great consideration. I will therefore attempt to reply to his objections as fully as space permits.

To his first indictment, that I apply to anthropological problems the crude phenotypic classifications of the serologist, while rarely making use of the accepted methods of genetical research, I would answer that the arguments for the preference to be given, in racial and ethnical studies, to the phenotypic or, vice versa, to the genetic data, have been already exhaustively dealt with, in an ample discussion between F. Lenz and J. Schwidetzky [Lenz, *Z. Morphologie und Abstammungslehre* (1940–41); Schwidetzky, and a last rejoinder by Lenz, *ibid.* **40**, No. 1 (1942–43)]. I need not therefore thrash out once again the *pros* and *contras*. The conclusion seemed to me at the time to be that, while for clinical and purely scientific studies preference should be given to the genetic approach, the phenotypic data were more adequate for ethnical problems; and it is this opinion that has guided me since.

With regard to Myslavec's assertion concerning the frequency of the AB group, I had it verified by K. Dürr, author of *Blut Auswertung* and a skilled mathematician, who obligingly compared a large number of phenotypic and genotypic series and arrived at the same conclusion as Myslaveč, namely, that the AB percentage conformed to expectations in the whites, was slightly, but not significantly, lower, in the Negroes, while it was often significantly above expectations in various Mongoloid series. I was then confirmed in my impression of its symptomological importance for ethnical classifications.

In Mongoloid series the frequencies for A, B, or O may vary considerably. For A, the variation is from 17 to 41 percent, or more; for B, from 19 to nearly 40 percent; for O, from less than 20 to around 40 percent. Corresponding percentages for these blood groups can be found in all the other races of mankind. If we had only the data for A and B, we would have to admit the absence of any common link, of any specific character that we could term "Mongoloid" in these so different series (not to consider the subgroups). If we observe, however, the AB group, this specific character is immediately apparent. Whatever be the variations for the other blood groups, the percentage of AB is uniformly high and varies comparatively little, between 10 and 15 percent, or sometimes a little more. It is thus, on an average, 5 times the mean value of AB in the whites, and 4 times this value in the Negroes. This is therefore, the common Mongoloid denominator, and we can tell at once simply by glancing at the frequency of AB, whether or not we have to do with a Mongoloid series. The racial significance of the AB group thus cannot be overrated, and consideration simply of the gene frequencies loses sight of this most valuable aid for ethnical

classification and analysis. Another instance of this is to be seen in two phenotypic series of Germans and Swedes:

	AB	A	B	O
	(percent)			
Germans (E. Friesland, Buchner, 646 cases)	1.5	52.3	13.3	32.9
Swedes (Stockholm, 500, Folgren, Vin.)	7.2	50.0	9.1	33.7

The most notable difference between these two series is that the percentage of AB in the Swedes is fivefold that of the Germans. The reason is that the Finns, owing to their Ural and Siberian origins, have a considerable Mongoloid component. The divergence in the Swedes, as to the proportion of AB, is thus clearly due to Finnish infiltration, naturally lacking in the Germans.

This interesting detection of the Finnish component in the Swedish series would not be obtainable with the Streng method, favored by Mourant. Transcribed into allelic frequencies, the two foregoing series would become the following:

	p	q	r	Total
Germans	32	7.8	57.4	97.6
Swedes	34.6	8.6	48.1	101.3

From this comparison no such useful indication, of the kind extracted from the phenotypes, could be drawn. Many similar instances could be given.

The AB group also permits one to distinguish the North African populations of the western Mediterranean basin from those of the eastern end of the Mediterranean (Egyptians and Arabs). The percentage of AB in the latter group is, on an average, nearly treble that of the western Mediterraneans.

All the more interesting is the geographic correlation between a high frequency of AB and an Asiatic origin, independent in large measure of race, inasmuch as Arabs, Iranians, and many Indians often have as high a percentage of AB as the Mongoloids. Many more instances of the great value of AB for ethnical research could be given. Disregard of this group and exclusive reliance on gene frequencies is doubtless the reason why Streng's results are, notwithstanding Mourant's preference, so often unsatisfactory, if not directly absurd. Streng utilizes for his ethnic index, the formula $I = (2p + q)/\sqrt{3}$. This yields such indices, for instance, as [O. Streng in *Die Bluteigenschaften der Völker*, Festschrift für H. Hirt (Heidelberg, 1936)]:

North Germans	38.2		Chinese	32.9
Abyssinians	38.4	or	Dutch	33.5
Norwegians	38.5		Iranians	34.3

The strangeness of these results needs no further comment and can only perplex and mislead the layman. But the prestige of what seems mathematical efficiency is so great, that undaunted, many other authors have also adopted procedures more or less similar to those utilized by Streng. I mention, as only one unfortunate instance, the graphical representation in J. Avias' study, "Les groupes sanguins des Néocalédoniens et des Océaniens, en général du point de vue de l'anthropologie raciale" [*L'Anthropologie* 53 (1949)]. This representation shows Hindus and Japanese, Caucasian peoples and Australian natives, African blacks and the oceanic inhabitants of the Admiralty Islands, Australian natives and Eskimos, and so forth, paired in the most brotherly way. If a method is to be judged by its results, we cannot agree that this one is "efficient."

Moreover, the Streng method can deal only with three variables at most. It is thus entirely inadequate to give full expression in its triangular diagrams to the various frequencies of the Rh system, although this system is fast becoming, probably, the most important one for human classifications. On the contrary, my simple method can cope with any number of variables, by the rough and ready process of summing up all the differences deriving from the various frequencies observed in any given blood system. Thus, notwithstanding the similarity in the ABO system, say of Australians and Eskimos, we can immediately see by their very high "index of deviation," both in the MN and in the Rh systems, that these populations are really entirely unconnected. The direction of the deviations can also be easily expressed.

A tree should be judged by its fruits. My method, however open to objections, avoids the fallacies noted in the foregoing paragraphs and works out better, in practice, than the other methods.

This may perhaps be because, as von Eickstedt, the German anthropologist, writes (*Rassenkunde und Rassengeschichte der Menschheit*, p. 544):

> . . . as all the investigations made so far are but samplings, it is an illusion to seek more than approximate truths . . . the more so, as biological, like physical phenomena, cannot be determined, as a rule, with mathematical precision. . . . The examination of a single series of characters may also lead to absurd results . . . the rigidity of algebraic and complicated mathematical constructions tends to obscure the essential sampling origin of our data, and the basic fluidity of biological factors, transforming provisional approximations into hard and fast truths—which they are not. . . .

NICOLAS LAHOVARY

Grandson, Switzerland

Received August 24, 1953.

The foregoing communications from W. C. Boyd, A. E. Mourant, and N. Lahovary have been greatly delayed in publication because Dr. Lahovary did not observe editorial restrictions on the length permissible for his rejoinder.

The rejoinder to W. C. Boyd in its present form is printed without curtailment, except for the list of 44 references cited in the text and with which Dr. Lahovary desired to document his reply; those interested may obtain this list in mimeographed form from the American Documentation Institute, Library of Congress, Washington, D.C. The rejoinder to A. E. Mourant appears in somewhat condensed form, with one lengthy table of data omitted entirely.

Association Affairs

Preliminary Announcement of the Berkeley, California, Meeting, Dec. 26–31, 1954

Raymond L. Taylor
Associate Administrative Secretary

The 121st Meeting of the American Association for the Advancement of Science, the annual meeting for the year 1954, will be unique in several respects. It will be the first national *winter* meeting of the AAAS west of the Rockies. Second, it will be the first time in recent years that the December meeting has been concentrated on one campus. Third, for the last week of the year, Berkeley will be the statistical capital of the world. However, all principal fields of science will be represented. The number and variety of participating organizations, in addition to the 18 sections and subsections of the Association, indicate that this year's national AAAS meeting will be by far the largest diversified scientific meeting ever held on the Pacific Coast.

Consistent with the westward shift of the nation's population and increasing AAAS membership, the Association's meetings in the West have increased—though, at first, only gradually. The fifth meeting of the Association in 1851 in Cincinnati was the first meeting held west of the Appalachians. In 1872, the 21st meeting, in Dubuque, Iowa, reached the Mississippi. In 1901, the Association's 50th meeting was held in Denver, in the shadow of the Continental Divide, and then, 14 years later, the shore line of the Pacific at last was reached.

The 67th or "First Pacific Coast Meeting" of the AAAS, Aug. 2–7, 1915, was held with the double purpose of aiding in the development of science in that region and celebrating the completion of the Panama Canal. Some sessions were held in Berkeley, on the campus of the University of California, and some in San Francisco, downtown and on the grounds of the Panama-Pacific International Exposition next to the Presidio. A full day was scheduled at Stanford University. The Pacific Division of the Association had been organized, but it counts as its first meeting the one in San Diego, Aug. 1916. With the exception of the war years 1917 and 1943–45, inclusive, the AAAS Pacific Division has met each year throughout its territory.

With the first Pacific Coast Meeting a success, it is not surprising that thereafter the national AAAS, whenever possible, met summers with the Pacific Division: in 1922, at Salt Lake City; in 1923, at Los Angeles; in 1925, at Portland, Ore.; in 1931, at Pasadena; in 1934, at Berkeley; and in 1940, at Seattle. This year's national meeting of the Association, however, is the Association's first large-scale, or winter, meeting on the "Pacific Rim."

Usually, at a typical AAAS meeting, some sessions are held in academic buildings of universities in the convention city; but for many years it has been impossible to center the entire meeting at one institution. At Berkeley, however, the exceptional facilities of the compact campus of the University of California make possible a unified and convenient meeting. As host, the University of California most generously has offered every necessary facility: well-equipped session rooms in its newest classroom buildings; its cafeterias nearby; all dormitory units—with breakfasts served "in" if desired—and, quite without precedent, the large Gymnasium for Men which will house the Registration Center, the AAAS Science Theatre, and the Annual Exposition of Science and Industry. With some lounge facilities installed, this building, on Dana Street, will serve as the center of the meeting.

In addition to the meetings of the American Statistical Association, the Institute of Mathematical Statistics, and the Biometric Society, WNAR, the Third Berkeley Symposium on Mathematical Statistics and Probability will bring together the leading statisticians of all continents and, thus, lend a welcome international quality to the 121st Meeting. This Symposium, or Congress, held at intervals of 4 or 5 years, will have sections for both pure statistics and applications to astronomy, biology, public health, and other fields.

When the Board of Directors of the Association selected the Pacific Coast as a meeting place, the vote was unanimous and upon condition it would not interrupt the regular June meetings of the AAAS Pacific Division. It was further agreed that the administrative office of the Division would not be called upon to lend assistance beyond advice, information, and good wishes. Accordingly, the Pacific Division scheduled its 1954 and 1955 meetings in Pullman, Wash., and Pasadena, Calif.

Although the December AAAS meeting in Berkeley will not be a joint meeting with the Pacific Division, the Division will, in a sense, be host to the national organization. The Division's constituent societies—and its individual members—will enjoy playing hosts to their colleagues from other parts of the country.

Virtually all the societies that meet regularly with the Pacific Division will also have sessions for contributed papers, special programs, or both, at Berkeley. Societies that will hold their national meetings with the AAAS at Berkeley include the American Society of Limnology and Oceanography, the Society of Systematic Zoology, the National Association of Biology Teachers, the American Nature Study Society, the Meteoritical Society, and the seismologists. Other national societies arranging special programs include the American Society of Naturalists, the Ecological Society of America, the Mycological Society of America, the Society for Research in Child Development, and the National Science Teachers Association. Among the regional organizations, the annual December Pacific Coast meeting of the American Physical Society, the regular winter meeting of the Western Society of Naturalists, the Pacific Coast Entomological Society, the Western Psychological Association, the Astronomical Society of the Pacific, the California State Veterinary Medical Association, the Southern California and Northern California-Hawaiian Branches of the Society of American Bacteriologists, the Southern California and Pacific Coast Sections of the Society for Experimental Biology and Medicine, *et al.*, all will augment the attendance and make this a record-breaking scientific conclave.

Transportation. A trip to California is a memorable experience at any time and, in this modern period, the approach of winter need change no one's wish to reach Berkeley. In general, there is no reason to be uneasy about cancellation or serious interruption of scheduled transcontinental air and railroad service. Automobile transportation is feasible. The all-weather southern route via Arizona and the Great Valley permits a side trip to Grand Canyon.

Beginning with the April 9 issue of *Science*, a page in the advertising section outlines the one-way travel time between New York, Washington, Chicago, and San Francisco. Also given are the round-trip fares, with the new lowered 10 percent federal transportation tax included.

Housing. Sleeping accommodations are unlimited but, of course, vary in their convenience to the campus. Those in Berkeley alone can accommodate 2500 persons, since all the dormitories, a block of rooms at International House, and all hotels and motels are committed. In reserve are the housing facilities of the neighboring community of Oakland and of San Francisco, across the great Bay Bridge. All housing will be handled by the AAAS Housing Bureau, which will be operated by the Berkeley Convention Bureau.

The dormitories of the University, accommodating about 750 persons, will be available at a uniform rate of $2 per person the *first night* and $1 per night thereafter. Priority for these will be given to students and younger scientists. In the hotels, single rooms range from $4 to $10 per night at the Shattuck and Durant, for example; $5 to $11 at the Claremont; all have rooms without bath at $3 per night. All motels charge $4 to $5 per night per single room; $5.50 to $8 for twin-bed rooms. The motels not close to the campus will be assigned to those who drive to the meeting. Headquarters of each participating society will be given in a later announcement. Detailed housing information and a coupon for room reservations will appear in *Science* and *The Scientific Monthly* beginning in July.

Advance registration. As in recent years, advance registrants will receive the General Program-Directory early in December by first-class mail. Coupons will appear in the AAAS journals beginning in late July.

Tours. A committee on tours has not been appointed but it is anticipated that there will be a demand for tours to the following: (i) Strawberry Canyon, the Berkeley Hills, Mount Diablo; (ii) California Academy of Sciences in Golden Gate Park—Museum, Aquarium, new Planetarium; (iii) Mount Tamalpais and Muir Woods (redwoods); (iv) Stanford University and Mount Hamilton.

AAAS general symposium. By custom, the President of the Association is chairman of the Symposium Committee and, with the approval of the Board of Directors, he appoints the remaining members. The 1954 Symposium Committe consists of Warren Weaver, Rockefeller Foundation, *chairman*; George W. Beadle, California Institute of Technology; Fred N. Briggs, University of California, Davis; Perry Byerly, Adriance S. Foster, Joel H. Hildebrand, Ernest O. Lawrence, Jerzy Neyman, Robert G. Sproul, Wendell M. Stanley, and Otto Struve, all of the University of California, Berkeley; Joseph Kaplan, Louis B. Slichter, and Stafford L. Warren, of the University of California, Los Angeles; Harry J. Deuel, Jr., University of Southern California; Donald H. McLaughlin, Homestake Mining Company, San Francisco; Robert C. Miller, California Academy of Sciences; Roger R. Revelle, Scripps Institution of Oceanography; Robert R. Sears and Douglas M. Whitaker, of Stanford University; and Raymond L. Taylor, AAAS, *secretary*.

The Committee met at Berkeley on Feb. 25 and decided on one general symposium, "Science and society," the three sessions of which will be held on three consecutive afternoons beginning at 4 P.M. The individual sessions were outlined in a preliminary way and were made the responsibility of three program chairmen as follows: I. "Resources," Louis B. Slichter; II. "Population problems," Curt Stern, University of California, Berkeley; III. "Impact of science on society," Roger R. Revelle.

Special sessions. The special sessions that have already been planned are as follows: Dec. 27, annual address of Phi Beta Kappa (15th in the series), 8:30 P.M.; Dec. 28, AAAS Presidential Address by E. U. Condon, 8 P.M., followed by a reception; Dec. 29, Society of the Sigma Xi annual address (annual since 1922), 8:30 P.M.; Dec. 30, Scientific Research Society of America annual address (6th in the series), 8:30 P.M. The Pacific Science Board will sponsor an address, and the National Geographic Society will have its usual excellent lecture and accompanying film.

The Programs

A—Mathematics

Section A and the *American Mathematical Society* will have joint sessions on two days for contributed papers and invited addresses, and will cosponsor appropriate programs. The *American Statistical Association* will hold a regional meeting, with Maurice I. Gerahenson as program chairman. Among the sessions being arranged are: "Regional indexes of business activity" and "Regional unemployment estimates" with cosponsorship by the *Pacific Coast Committee on Social Statistics* of the Social Science Research Council; the society's Committee on Statistics in the Physical Sciences is developing sessions on "What does probability mean to the engineer, physicist, and mathematician?" and will cosponsor a number of the other statistical sessions. The annual national meeting of the *Institute of Mathematical Statistics* will be held with the AAAS in Berkeley Dec. 26–31, inclusive. Under the direction of Jerzy Neyman, the *Third Berkeley Symposium on Mathematical Statistics and Probability* will have sessions for papers devoted to mathematical statistics proper; applications to mathematics, astronomy, physics, and engineering; applications to genetics and biology; and applications to public health.

B—Physics

Section B will schedule a vice-presidential address by George R. Harrison and will cosponsor appropriate programs. The *American Physical Society* will hold its regular December meeting with sessions for contributed papers and for invited addresses. Under the chairmanship of Cornelius A. Tobias, the *Donner Laboratory* of the University of California will arrange a symposium, "Biological structures: Biophysics of growth," cosponsored by the American Physical Society and probably by AAAS Sections B and N. The 133rd national meeting of the *American Meteorological Society* will consist of six or more sessions for invited and contributed papers. *Sigma Pi Sigma* will cosponsor the Physicists' Dinner.

C—Chemistry

Section C will have several sessions for contributed papers, symposia, the Chemists' Dinner, and a vice-presidential address by Wendell M. Latimer. *Alpha Chi Sigma* will sponsor a luncheon. It is probable that Harry S. Mosher will arrange a program for the California Section of the *American Chemical Society*. The *Pacific Southwest Association of Chemistry Teachers* will have a program.

D—Astronomy

Section D plans a vice-presidential address by Bart J. Bok and joint symposia, "Statistics of extra-galactic nebulae" and "Statistics of the Hertzsprung-Russell diagram," with the *Statistical Laboratory* of the Univer-

sity of California, together with the cosponsorship of the program of the *Astronomical Society of the Pacific* and joint sessions for contributed papers Dec. 27–29, inclusive. The national meeting of the *Meteoritical Society* will comprise four sessions.

E—Geology and Geography

Section E is scheduling several sessions for contributed papers in both geology and geography, a two-session symposium, "Earth sciences from the air," the Geologists' Smoker, and a vice-presidential address by Meredith F. Burrill. The *Geological Society of America* will cosponsor Section E's sessions. The *California State Division of Mines* will conduct tours and display some exhibits. A regional meeting of the *Seismological Society of America* is scheduled. The *National Speleological Society* will hold a regional meeting and the *Arctic Institute of North America* will cosponsor one of the symposia of the Western Society of Naturalists.

F—Zoological Sciences

Section F plans some sessions for contributed papers in fields of zoology other than systematic zoology, the cosponsorship of appropriate symposia of other societies, a vice-presidential address by Horace W. Stunkard, and the cosponsorship of the Zoologists' Dinner. Under the direction of C. V. Duff, the *Cooper Ornithological Society* will have a joint meeting of the Northern and Southern Divisions. The *Herpetologists League*, with Angus M. Woodbury arranging the program, will have a session for contributed papers, a symposium, an informal session for unlisted papers, and a dinner. The *Pacific Coast Entomological Society* will have one or more sessions. The *Society of Systematic Zoology*, with Robert C. Stebbins as program chairman, plans a national meeting, with its Western Division as host, which will include sessions for contributed papers in systematic zoology and evolution, symposia, and the cosponsorship of the Zoologists' Dinner.

FG—Zoological and Botanical Sciences

Among the societies whose fields lie in both botany and zoology, the *American Society of Limnology and Oceanography* will hold its national meeting and have five sessions for contributed papers and a symposium, "Recent advances in biological oceanography," organized by R. W. Hiatt. A symposium is scheduled for a special meeting of the *American Society of Naturalists*. The *Biometric Society, WNAR*, will have sessions for contributed papers and joint sessions with the *Institute of Mathematical Statistics*. Russel K. LeBarron and E. C. Stone will be cochairmen of the program of the *Ecological Society of America*, under the sponsorship of its Western Section. The program includes two days of sessions for contributed papers, a symposium on "Is dew an important ecological factor?" an all-day field trip, and a dinner. The *National Association of Biology Teachers* will hold its national meeting with a program on conservation, sessions for contributed papers, panels, a field trip to Muir Woods, and other sessions jointly with the *American Nature Study Society*. Plans for the regular annual meeting of the *Western Society of Naturalists* are being arranged by John L. Mohr and Richard Eakin for Dec. 27–29. The program consists of symposia on "Conservation of natural resources of the West," arranged by Arthur C. Giese, and "The cell," arranged by Daniel Mazia and Roger Stanier; and there will be concurrent sessions for invited and submitted papers on photobiology, parasitology, ecology, histology-embryology, physiology, natural history, teaching problems in biology, and arctic biology. The society will have a banquet for all naturalists. The *Society of General Physiologists*, with Albert Tyler as program chairman, will have at least a day of contributed papers and will cosponsor the preceding symposium, "The cell."

G—Botanical Sciences

Section G plans cosponsorship of appropriate programs and probably will have sessions for contributed papers not covered by the participating societies of Section G. The vice-presidential address will be given by Stanley A. Cain, and the section will cosponsor the Botanists' Dinner. The Pacific Division of the *American Phytopathological Society* will have, at its special meeting, a conference on control of soil microorganisms associated with plant diseases, a symposium on "Crop sequence and plant disease control," three concurrent sessions of general and invited papers, and a banquet. The *Mycological Society of America* will have two joint symposia with the phytopathologists, "Physico-chemical control of structural differentiation in the fungi" and "The mode of survival of plant pathogens in the soil"; and sessions for contributed papers. The Western Section of the *American Society of Plant Physiologists* is sponsoring a symposium but no sessions for contributed papers. The *Botanical Society of America* will probably cosponsor appropriate programs.

H—Anthropology

Section H is scheduling sessions for contributed papers in anthropology and archeology, symposia on "Indians of Western North America" and "Culture change in the Pacific," and several other symposia.

I—Psychology

Section I plans sessions for invited papers on the following subjects: the nervous system and behavior, arranged by Donald B. Lindsley; human factors in engineering design, Arnold Small; experiments in social psychology, Richard Crutchfield; research in child psychology, Harold E. Jones; learning, John P. Seward; and psychological factors in highway safety, T. W. Forbes; sessions for contributed papers; and vice-presidential address by Dr. Lindsley. The *Society for Research in Child Development*, with Robert R. Sears as program chairman, is planning a day of sessions. The *Western Psychological Association* will have three symposia, arranged by Rheem F. Jarrett, as follows: "Perception: learned and unlearned," "The present status of psychoanalytic theory," and "Sex differences in personality and intellectual development"; and an invited address.

K—Social and Economic Sciences

Organized last year, the Section K program committee, representing nine participating societies and headed by Harold E. Jones, has decided upon five symposia presented by panels as follows: "Pacific coast population trends," Calvin Schmid, chairman; "The structure of cities," Leonard Broom, chairman; "Regional and inter-regional economic problems," David Revzan, chairman; "Organization of research on western development," Ernest Engelbert, chairman; and "Cost-benefit analysis," M. L. Upchurch, chairman. The *Western Economic Association* will participate as a cosponsor. The section will have a dinner meeting Dec. 29, at which vice president J. B. Condliffe will deliver his address entitled "The international consequences of scientific research." The *National Academy of Economics and Political Science* will have a

symposium on the Randall Report. The *Committee for Social Physics* will have three sessions, "Diffusion theory," "Human values measurement," and "Isomorphisms," arranged by Stuart C. Dodd. The *Society for the Advancement of Criminology* is arranging a program with William Dienstein, chairman.

(Note: The programs of the *American Statistical Association* and other groups in statistics will be found under A—Mathematics.)

L—History and Philosophy of Science

Section L plans sessions for contributed papers and symposia and a vice-presidential address. The *Philosophy of Science Association* will have several sessions.

M—Engineering

Baldwin M. Woods, program chairman for Section M, reports that no less than eight sessions are being planned as follows: "Prosthetic devices," arranged by Eugene Murphy; "Highway safety—relation of eye defects to accidents"; "Seismology"; "Oceanography (ocean as a source of food)"; "Water, irrigation, and power"; "Stream pollution"; "Present state of the smog problem"; "Highest use of raw materials."

N—Medical Sciences

Alpha Epsilon Delta National Premedical Honor Society will schedule a general session on premedical education, a luncheon, and workshop groups. A symposium is being arranged for the meeting of the *American Academy of Forensic Sciences* by Ralph F. Turner. The *American Association of Hospital Consultants* is scheduling a symposium, as is the *American Psychiatric Association*. The *California State Veterinary Medical Association* is planning sessions for its regular winter meeting. David M. Greenberg is arranging two sessions for contributed papers for the meeting of the *Pacific Slope Biochemical Conference*. The *Society of American Bacteriologists* is scheduling a joint meeting of its Southern California and Northern California-Hawaiian Branches. Paul Starr and Robert H. Dreisbach, program chairmen of the *Society for Experimental Biology and Medicine* at the joint meeting of the Southern California and Pacific Coast Sections, plan one session for papers and another for a symposium, "Adrenal-pituitary relationships." An important three-day international *Conference on Animal Venoms* is being arranged by Nandor Porges and will be cosponsored by Sections F and N.

Subsection Nm—Medicine

Subsection Nm will sponsor a four-session symposium on cancer entitled "Physiology of growth—normal and abnormal," being arranged by Howard R. Bierman. The vice-presidential address will be given by Charles B. Huggins and the 1954 Theobald Smith Award will be presented.

Subsection Nd—Dentistry

Subsection Nd plans symposia on "Hazards of dental radiation" and "Growth and development"; these will be cosponsored by the *International Association for Dental Research*, the *American Dental Association*, and the *American College of Dentists*.

Subsection Np—Pharmacy

Subsection Np is scheduling sessions for contributed papers and symposia, cosponsored by six national pharmaceutical societies.

O—Agriculture

Section O is planning four groups of invited papers on "Agricultural problems of the Far West" dealing with "Soil management problems in western agriculture," H. B. Cheney, chairman; "Water supplies and irrigation," F. J. Veihmeyer, chairman; "Seed production in the western states," J. G. Parsons, chairman; and "Problems in vegetable crops," J. E. Knott, chairman.

P—Industrial Science

Section P will have a round-table conference on some phase of industry and basic research and a luncheon.

Q—Education

Section Q will have two sessions for contributed papers; joint sessions with the *American Educational Research Association*, with the *International Council for Exceptional Children*, and with the Third Berkeley Symposium on Mathematical Statistics and Probability; and the vice-presidential address by George C. Kyte. The *AAAS Cooperative Committee on the Teaching of Science and Mathematics* is scheduling a symposium. The *National Science Teachers Association*, with Robert Stollberg as program chairman, is arranging sessions for invited papers and panels at its regional meeting. "Recent advances in science" should be of wide interest. The buffet supper and mixer for all science teachers will be Dec. 27.

X—Science in General

At its annual meeting, the *Academy Conference* will arrange for an all-day round-table conference and a dinner. The *American Geophysical Union* will cosponsor appropriate programs. Under the program chairmanship of Ruth E. Hopson, the *American Nature Study Society*, at its national meeting, joint with its Western Division, is planning sessions for invited papers, panels, and its annual presidential address. The *California Academy of Sciences* will participate in the AAAS meeting in various ways. Again, for the third time, Mrs. Marian Fineman will arrange several sessions for the *Conference on Scientific Editorial Problems*. A business meeting, and perhaps a session, will be held by the *Honor Society of Phi Kappa Phi*. At its regular meeting, the *National Association of Science Writers* will have a symposium. It is probable that the *Sierra Club* will have joint sessions with the ANSS. The *Society of the Sigma Xi* and the *Scientific Research Society of America* will sponsor evening addresses on Dec. 29 and 30, respectively, and will hold their annual conventions with the AAAS on December 30, morning and afternoon, respectively. The *National Geographic Society* and the *United Chapters of Phi Beta Kappa* will arrange evening addresses, the latter scheduled for Dec. 27. The *Pacific Science Board* will sponsor an afternoon address by Alexander Spoehr, director, Bernice P. Bishop Museum, Honolulu.

Committee Appointments for 1954

(Numerals in parentheses indicate year of expiration of term)

AAAS Research Grants

Barry Commoner, *chairman*, Washington University
Laurence H. Snyder
H. Burr Steinbach
Allan P. Colburn
Lowell Kelly
Hans Nussbaum
Dael Wolfle, ex officio

AAAS Symposium Committee, Berkeley Meeting
(See page 781)

Affiliation and Association
(1954) Karl Lark-Horovitz
(1955) L. V. Domm, *chairman*, Loyola University, Chicago
(1956) Fernandus Payne
(1957) I. Melville Stein
(1958) Howard A. Meyerhoff
Dael Wolfle, ex officio

Representatives on American Council on Education
Walter Hunter, Brown University
Mark Ingraham, University of Wisconsin

Building Committee
John R. Dunning, *chairman*, Columbia University
Wallace R. Brode
Paul E. Klopsteg
Warren Weaver
Dael Wolfle, ex officio

Constitution, Bylaws, and General Operations
Wallace R. Brode, *chairman*, National Bureau of Standards
Roger Adams
Meredith F. Burrill
Clarence E. Davies
Milton O. Lee
Howard A. Meyerhoff, Dael Wolfle } Advisors

Representative of Board of Directors on Cooperative Committee on the Teaching of Science and Mathematics
Harold Schilling, Pennsylvania State University

Representative on Council of National Organizations of the Adult Education Association of the United States
John A. Behnke, AAAS

Representative on Council of Old World Archeology
Richard K. Beardsley, University of Michigan

Executive Committee
E. U. Condon, *chairman*, retiring president and chairman of the Board of Directors
Warren Weaver, president
George Beadle, president elect
Wallace Brode
Paul Klopsteg
Dael Wolfle

Investment and Finance
(1957) F. P. H. Siddons, *chairman*, American Security & Trust Co., Washington, D.C.
(1956) Sheldon B. Akers, *vice chairman*
(1954) Paul E. Klopsteg
(1955) L. Clark Brown
(1958) Malvern F. Morse
Dael Wolfle, ex officio
Paul A. Scherer, ex officio

Management and Business Operations
Mark Ingraham, *chairman*, University of Wisconsin
F. P. H. Siddons
George J. Beal
Dael Wolfle, ex officio
Paul A. Scherer, ex officio

Membership Development
Ralph Gerard, *chairman*, University of Illinois, Chicago
Rensis Lickert
Clarence E. Davies
Dael Wolfle and all members of the staff as consultants

Representative on National Citizens Committee for Educational Television Advisory Committee
John A. Behnke, AAAS

Representative on National Committee for UNESCO
Elvin C. Stakman, University of Minnesota, St. Paul

Representative on National Conference of Non-Governmental Organizations on FAO
Noble Clark, University of Wisconsin, Agricultural Experiment Station

Publications Committee
(1954) Paul Sears, *chairman*, Yale University
(1955) E. U. Condon
(1956) Walter Hunter
(1957) Thomas Park
(1958) Ralph Shaw
Dael Wolfle, ex officio

Retirement Plan (must be three staff members)
Dael Wolfle, *chairman*, AAAS
Raymond L. Taylor
Hans Nussbaum

Scientific Directory
Detlev W. Bronk, *chairman*, Rockefeller Institute for Medical Research
E. U. Condon
Paul E. Klopsteg
Dael Wolfle, ex officio
John A. Behnke, ex officio

Representatives on Board of Trustees of Science Service
(1954) Fernandus Payne, Indiana University
(1955) Karl Lark-Horovitz, Purdue University
(1956) Kirtley Mather, Harvard University

Representatives on Scientific Manpower Commission
Wallace Brode, National Bureau of Standards
Detlev Bronk, Rockefeller Institute for Medical Research

Source Books in the History of Science
Gregory D. Walcott, *chairman*, Long Island University
Harlow Shapley
Edmund W. Sinnott
Dael Wolfle, ex officio

Representative on U.S. Committee on ISO Technical Committee 37—Terminology
Duane Roller, AAAS

Representatives on World Federation of Associations for the Advancement of Science
Kirtley Mather, *chairman*, Harvard University
Detlev W. Bronk
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Committees to be appointed: Resolution; $1000 Prize in Sociology; Theobald Smith Award; Newcomb Cleveland Prize.

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International Union for the Protection of Nature

THE International Union for the Protection of Nature was founded in 1948 at Fontainebleau at an international conference that was held at the invitation of the French Government and with the assistance of UNESCO. The United States was represented by an official delegation under the chairmanship of Ira N. Gabrielson. Since that time the Union has played an increasingly active part in furthering nature protection, which they define as "the conservation and wise use of the entire world biotic community, or man's natural environment, which includes the earth's renewable natural resources of which it is composed, and on which rests the foundation of human civilization."

The Union will hold its Fourth General Assembly at Copenhagen from Aug. 25 to Sept. 3 at the invitation of the Danish Government. Previous assemblies have been held in Fontainebleau (1948), Brussels (1950), and Caracas (1952). The program will include technical meetings dealing with the protection of arctic fauna; the effects of modern insecticides on mammals, birds, and insects; and various methods and means of publicity for nature protection. There will also be special meetings to discuss plans for the Union's policy regarding the population problem and the relationship of ecological research to nature protection.

In addition to the statutory meetings, the organizing committee has made arrangements for a number of special excursions. These will include a visit to southern Sealand, the Island of Lolland, and Jutland.

Invitations have been addressed to governments and associations that are members of the Union requesting them to send delegates or observers. Since the United States Government does not belong to the Union, anyone wishing to attend the Copenhagen assembly should communicate without delay with the Secretariat of the Union at 42 Rue Montoyer, Brussels, Belgium, or with one of the following member organizations: American Committee for International Wild Life Protection, American Geographical Society, American Museum of Natural History, American Nature Association, American Ornithologists' Union, American Shore and Beach Preservation Association, Boone & Crockett Club, Conservation Foundation, Iowa State Conservation Commission, National Audubon Society, National Parks Association, National Research Council, National Wildlife Federation, Nature Conservancy, New York Zoological Society, North American Wildlife Foundation, Occidental College, Wilderness Society, Wildlife Management Institute, and Wildlife Society.

The organizing of the assembly in Copenhagen is being handled by the internationally known Naturfredningsraadet, the address of which is Sortedam Dossering 23, Copenhagen N.

HAROLD J. COOLIDGE

National Research Council
Washington 25, D.C.

SCIENCE, founded in 1880, is published each Friday by the American Association for the Advancement of Science at Business Press, Lancaster, Pa. Entered at the Lancaster, Pa., Post Office as second class matter under the Act of March 3, 1879.

All correspondence should be addressed to SCIENCE, 1515 Massachusetts Ave., NW, Washington 5, D. C. Manuscripts should be typed with double spacing and submitted in duplicate. The AAAS assumes no responsibility for the safety of manuscripts or for the opinions expressed by contributors.

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The AAAS also publishes THE SCIENTIFIC MONTHLY. Subscription and advertising rates will be furnished on request.

Miscellaneous Publications

Forest Statistics for Central Maryland. Wayne G. Banks. 19 pp. + map. ***Forest Statistics for New York, Forest District No. 3.*** 19 pp. Northeastern Forest Expt. Station, USDA, Upper Darby, Pa., 1953.

Frequency Analysis of Hydrologic Data with Special Application to Rainfall Intensities. Bull. Ser. No. 414. Ven Te Chow. Univ. of Illinois Engineering Expt. Station, Urbana, 1953. 80 pp. Illus. 80¢.

***The Fungal Diseases of Sal* (Shorea robusta *Gaertn*).** Pt. I. Indian Forest Records, Mycology Ser., Vol. 1, No. 2. K. Bagchee. Manager of Publications, Delhi, India, 1953. 23 pp. + plates. 2s.

Further Studies of the Physical Interactions between Tropical and Temperate Latitudes. Section of Meteorological Physics, Tech. Paper No. 1. C. H. B. Priestley and A. J. Troup. Commonwealth Scientific and Industrial Research Organization, Melbourne, Australia, 1954. 22 pp. Illus.

Genes, Mice and Men. A quarter-century of progress at the Roscoe B. Jackson Memorial Laboratory. The Laboratory, Bar Harbor, Maine, 1954. 43 pp. Illus.

Gluing Techniques for Beech. Beech Utilization Ser. No. 5. W. Z. Olson and R. F. Blomquist. 20 pp. ***Beech for Veneer and Plywood.*** B.U.S. No. 6 H. O. Fleischer. 24 pp. Illus. ***Beech for Flooring.*** B.U.S. No. 8. E. A. Lefkof. 11 pp. Illus. Northeastern Forest Expt. Station, USDA, Upper Darby, Pa., 1953.

Guide des Centres Nationaux d'Information Bibliographique (In French). UNESCO, Paris, 1953 (Order from Columbia Univ. Press, New York 27). 68 pp.

Health Inquiry: The Toll of Our Major Diseases—Their Causes, Prevention, and Control. Preliminary Report. Committee on Interstate and Foreign Commerce, House of Representatives, Washington, D.C., 1954. 206 pp.

Index to Schoolcraft's "Indian Tribes of the United States." Smithsonian Institution, Bur. of American Ethnology Bull. 152, 1954. Compiled by Frances S. Nichols (Order from Supt. of Documents, GPO, Washington 25, D.C.). 257 pp. $1.25.

Interrelations of Cultures: Their Contributions to International Understanding. Collection of intercultural studies. Richard McKeon *et al.* UNESCO, Geneva, 1953. (Order from Columbia Univ. Press, New York 27). 387 pp. $2.

Studies on Fish Preservation at the Contra Costa Steam Plant of the Pacific Gas and Electric Company. Fish Bull. No. 92. James E. Kerr. California State Fisheries Laboratory, San Pedro, 1953. 66 pp. Illus.

Surface Water Resources of Iowa, Oct. 1, 1942 to Sept. 30, 1950. Water-Supply Bull. No. 3. Samuel Mummey, Jr. Iowa Geological Survey, Iowa City, 1953. 583 pp. Illus.

Tlatilco and the Pre-Classic Cultures of the New World. Viking Fund Publications in Anthropology, No. 19. Muriel Noé Porter. Wenner-Gren Foundation for Anthropological Research, New York 21, 1953. 104 pp. Illus. + plates. $2.50.

Uruguay, Vol. II. Scientific institutions and scientists of Uruguay. UNESCO, Montevideo, 1953. 259 pp.

Waterfowl of North Dakota. Paul A. Johnsgard. North Dakota Institute for Regional Studies, N. Dak. Agric. Coll., Fargo, 1953. 16 pp. Illus. Free.

Zein (Corn protein): ***An Annotated Bibliography, 1891–1953.*** Bibl. Ser., Bull. No. 7. Dorothy M. Rathmann. Mellon Institute, Pittsburgh, Pa., 1954. 118 pp.

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TRAVEL ARRANGEMENTS FOR THE AAAS BERKELEY MEETING

December 26-31, 1954

In time or in cost, a trip from an eastern city to California is not much more than a **round trip** to a midwestern city. Californians who for years have been attending meetings in the East have told their colleagues that the continental distance is the **same** each way, and that it should be the turn of the Easterners to visit the Pacific Coast.

The Association is planning ways it may assist those who will attend the 121st AAAS Meeting on the campus of the University of California at Berkeley, this December. The possibilities include:

1. Low cost AAAS limousines from Oakland and San Francisco airports and railroad terminals direct to the dormitory or hotel of each delegate.
2. Arrangements for traveling together in AAAS cars on fast trains leaving Chicago, Washington, D. C., and New York.
3. Arrangements for chartering first class DC6, 6B, or 7 planes of scheduled airlines—at prices comparable with air coach travel.

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Reclining seat coach	$ 99.17	$147.62	$156.64
First class	$139.10	$204.33	$222.67
Lower berth	46.20	60.06	63.58
Total	$185.30	$264.39	$286.25
By Air	Time: 7–8 hrs., leaving a.m. or p.m., Dec. 26; returning a.m. or p.m. Dec. 31	Time: 10–11 hrs., leaving a.m. or p.m., Dec. 26; returning a.m. or p.m., Dec. 31	Time: 10–11 hrs., leaving a.m. or p.m., Dec. 26; returning a.m. or p.m., Dec. 31
Air coach (no meals)	$167.20	$215.60	$217.80
Chartered 1st class (meals included)	c. $178.00	c. $235.00	c. $235.00
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Meetings & Conferences

June

25–29. Inst. of Aeronautical Sciences, New York, N.Y. (S. P. Johnston, 2 E. 64 St., New York.)

27–1. Inst. of Food Technologists, annual, Los Angeles, Calif. (C. S. Lawrence, 176 W. Adams St., Chicago 3, Ill.)

28–29. National Science Teachers Assoc., New York N.Y. (R. H. Carleton, 1201 16 St. NW, Washington 6, D.C.)

28–30. American Assoc. of Physics Teachers, Minneapolis, Minn. (R. F. Paton, Univ. of Illinois, Urbana.)

28–30. American Physical Soc., Minneapolis, Minn. (K. K. Darrow, Columbia Univ., New York 27.)

28–30. American Soc. of Heating and Ventilating Engineers, 60th semiannual, Swampscott, Mass. (Sec., ASHVE, 62 Worth St., New York 13.)

28–2. European Cong. of Gastroenterology, 4th, Paris, France. (A. Busson, 63 bis Rue de Varenne, Paris 7.)

28–3. National Education Assoc., annual, New York, N.Y. (L. W. Ashby, 1201 16 St. NW, Washington, D.C.)

29–3. International Conf. on Semiconductors, Amsterdam, The Netherlands. (H. J. Vink, Floralaan 142, Eindhoven, Netherlands.)

30–2. Heat Transfer and Fluid Mechanics Inst., Berkeley, Calif. (H. A. Johnson, Dept. of Mechanical Engineering, Univ. of California, Berkeley.)

July

1–9. British Medical Assoc., Glasgow, Scotland. (BMA, Tavistock Square, London, WC 1.)

2–8. International Cong. of Oto-Neuro-Ophthalmology, 19th, São Paulo, Brazil. (C. de Rezende, Hospital das Clinicas, Avenida Ademar de Barros, São Paulo.)

2–14. International Cong. of Botany, 8th, Paris, France. (P. Chouard, 11, Rue de Val-de-Grace, Paris 5.)

6–9. American Home Economics Assoc., San Francisco, Calif. (Miss M. Horton, 1600 20 St. NW, Washington, D.C.)

7–10. American Physical Soc., Seattle, Wash. (J. Kaplan, Univ. of California, Los Angeles.)

8–9. International Union of Pure and Applied Physics, 8th, London, Eng. (H. A. Barton, 57 E. 55 St., New York 22.)

8–12. Conv. on Industrial Electronics, Oxford, Eng. (Sec., Brit. I.R.E., 9 Bedford Sq., London, W.C.1.)

10–15. Latin American Cong. on Gynecology and Obstetrics, 2nd, São Paulo, Brazil. (J. Ramos, Av. Brigadeiro Luiz Antonio, 278–80, São Paulo.)

11–14. American Soc. of Refrigerating Engineers, Seattle, Wash. (M. C. Turpin, 234 5 Ave., New York 1.)

13–17. Conf. on Defects in Crystalline Solids, Bristol, Eng. (H. A. Barton, 57 E. 55 St., New York 22.)

13–17. Cong. on Experimental and Theoretical Nuclear Physics, Glasgow, Scotland. (H. A. Barton, 57 E. 55 St., New York 22.)

15–17. International Symposium on Solid Particles in Astronomical Objects, Liége, Belgium. (P. Th. Oosterhoff, Leiden Observatory, Leiden, Netherlands.)

15–21. Pan American Cong. of Child Welfare and Pediatrics, 4th, São Paulo, Brazil. (J. Ramos, Av. Brigadeiro Luiz Antonio 278–80, São Paulo.)

16–21: International Conf. on Electron Microscopy, London, Eng. (F. W. Cuckow, Royal Cancer Hospital, London, SW 3.)

(See the May 21st issue for summer meeting lists.)

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Biologist: Ph.D. 1953. Desires teaching with research opportunity; Botany, Biology, Ecology. Box 156, SCIENCE. X

Botanist: Ph.D., 1953, at present research fellow. Research publications in plant anatomy, morphology, tissue culture, histochemistry. Experience in photomicrography. Desires research position. Box 152, SCIENCE. X

Comparative Anatomist. M.S. Desires teaching position. Box 153, SCIENCE. 5/4, 11, 18

Ecologist, Ph.D. with zoological background, research and publication also on vegetation, ecological theory, and tracer applications in ecology. Desires teaching or research position in or near city. Box 136, SCIENCE. 5/21, 28; 6/4, 11, 18

(a) Endocrinologist, Ph.D.; six years, research department, large organization; prefers industrial research, will consider academic research. **(b) Pharmacologist;** Ph.D.; eight years, head, research department, pharmaceutical company. Science Department, Medical Bureau (Burneice Larson, Director) Palmolive Building, Chicago. X

Physical Chemist, experienced in proteins, Ph.D., 1953, veteran, age, 30. Desires research position. Metropolitan N. Y. area preferred. Box 155, SCIENCE.

Physiologist, Ph.D., histochemistry, endocrinology, publications, teaching experience, desires research position. Box 157, SCIENCE. X

Ph.D. Biochemistry—long experience as supervisor and professor—all phases of undergraduate chemistry. Box 121, SCIENCE. 5/28

Zoologist, Ph.D., 7 years teaching experience Comparative Anatomy, Histology, Genetics. Desires teaching position with research opportunity. Box 149, SCIENCE. 5/28

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POSITIONS OPEN

Applications are invited for position Department of Bacteriology, Hebrew University–Hadassah Medical School, Jerusalem, Israel, duties to commence October 1, 1954. Position vacancy in grade instructor, assistant or associate professor depending qualifications. For further information write Dr. Joseph Hirsh, Executive Secretary, Medical Advisory Board, 9 East 89th St., N.Y.C. 28, N. Y. X

(a) Biophysicist, Ph.D., with experimental and theoretical experience, background of mathematics, statistical methods; research involving effects of radiation; South. **(b) Physiologist,** Ph.D. or M.D., interested in cardiovascular research and, also, biochemist; new research department; large company; Midwest. **(c) Medical copy-writer;** pharmaceutical company; $7500. **(d) Parasitologist,** malariologist and laboratory technical assistant; experience, research tropical diseases; Africa. **(e) Clinical psychologist;** direct division, child guidance agency; university city, Southwest. **(f) Fellow** in pediatric allergy; physician with year or two training in pediatrics, particularly interested basic research and allergy or Ph.D. with similar interests; large teaching hospital. S5-4 Science Department, Medical Bureau (Burneice Larson, Director) Palmolive Building, Chicago. X

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